

ANNALS OF SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

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No. 1

ORIGINAL MEMOIRS.

THE AMERICAN SURGICAL ASSOCIATION. ITS INFLUENCE ON THE GROWTH AND DE- VELOPMENT OF AMERICAN SURGERY.*

BY CHARLES A. POWERS, M.D.,

OF DENVER,

Professor of Clinical Surgery in the University of Colorado.

THE American Surgical Association has now completed thirty-three years of active life, and in selecting a subject for a Presidential Address before it I have thought it not improper to consider some features in the history of this body, a history which has been at all times highly creditable and of which we may well feel more than proud, together with some of the conditions which have attended the recent development of American surgery and the place which our school occupies in the modern surgical world. My treatment of this subject will necessarily be more or less discursive. I am fully cognizant of my own shortcomings in the matter of accomplished work but I have been a close student of surgical conditions in our country for thirty years and I have an unbounded pride in the splendid achievements of my fellow countrymen.

Our Association has exerted a profound influence upon the growth and development of American surgery: we as

* Presidential Address Delivered before the American Surgical Association, Washington, May 6, 1913.

[NOTE.—For obvious reasons details regarding business matters pertaining to the affairs of the Association are omitted here.—C. A. P.]

individuals owe it more than we perhaps realize. I know that our distinguished Fellow, Dr. Mears, an original member, has made this the subject of interesting and instructive contributions, but I have felt that the impressions of one who entered the ranks during the mid-period of the Association's life might prove of supplemental value.

The beginning of our Association was simple and dignified. The project had its inception in the mind of that master surgeon, Dr. Samuel D. Gross, who confided details of his plan to a few of his friends at the meeting of the American Medical Association held at Atlanta, Ga., in May, 1879. It was agreed that on the following day, immediately after the adjournment of the surgical section of the Association, he should, in a brief speech, lay the plans agreed upon before that body. This having been done, the meeting was organized by the appointment of the eminent and venerable Dr. L. A. Dugas, of Augusta, Professor of Surgery in the Medical College of Georgia, as Chairman and Dr. William W. Dawson, of Cincinnati, Professor of Surgery in the Medical College of Ohio, as Secretary. Brief addresses were made by different gentlemen, all cordially approving of the objects of the meeting. It being apparent, however, that the kind of an organization desired could not be then effected, nothing further was done on that occasion. Before separating Dr. Gross and his associates decided that a circular should be sent to the principal surgeons of the United States, setting forth their plans and inviting co-operation at a conference to be held in New York during May or June, 1880.

Organization was perfected at this next meeting which was held in the lecture room of the college of Physicians and Surgeons, Twenty-third Street and Fourth Avenue, New York City, on May 31, 1880, forty-eight gentlemen signing the constitution and thus becoming Fellows¹ of the Society.

Dr. Gross was made President and Dr. Weist, of Richmond, Ind., Secretary. A Constitution and By-Laws were temporarily adopted. The next meeting was held in Rich-

¹Of these forty-eight gentlemen but three, Drs. Keen, Mears and Marks, are now living.

mond, Va., May 5, 1881, nineteen Fellows being present. No scientific papers were presented. The meeting of 1881 was held at Coney Island, New York, September 13, 14, and 15. Eleven Fellows were present and five surgical theses were read and discussed. Dr. Gross was re-elected President.

The meeting of 1882 was held in the hall of the College of Physicians, Philadelphia, on the last day of May and the first two days of June. Twenty-five Fellows registered and fifty gentlemen, from various parts of the country, were elected to active fellowship. Fear had been expressed that the Association would affect the strength of the American Medical Association. This was vigorously denied by Dr. Gross,² who said: "We can hurt no Society now in existence, or likely to come into existence. We can hurt only ourselves if we fail to do our duty. We hope to make the American Surgical Association an altar upon which we may annually lay our contributions to science, and so show to the world that we are earnest and zealous laborers in the interest of human progress and human suffering." Dr. Gross claimed that the American Medical Association would be strengthened by the new organization. That his prediction came true is realized by all of us who attend the splendid meetings of the Section on Surgery of that body.

At this meeting of 1882 four scientific papers were read and discussed, a large portion of the time of meeting being occupied in perfecting organization. Although he vigorously protested, Dr. Gross was again elected to the Presidency.

The meeting of 1883 was held in Cincinnati, forty Fellows signing the register. The Association urged its venerable President to accept a re-election, but this he steadfastly declined and the eminent Dr. E. M. Moore of Rochester, New York, was made his successor. Before adjourning the following resolution was unanimously adopted: "Resolved, That a vote of thanks be returned to our retiring President, Samuel D. Gross, and that the members of the Association unite in the hope that he may long be spared to meet with us.

²Dr. Gross had been the Chairman of the Section on Surgery of the American Medical Association in 1867, 1870 and 1873.

to cheer us by his presence and to guide us by his wise counsels."

The fifth annual meeting was held at Washington, April 30, May 1, 2 and 3, 1884, forty-three Fellows being present. The venerable founder was absent on account of illness, his paper on "Wounds of the Intestines" being read by Dr. T. G. Richardson. On motion, the following telegram was ordered sent:

Professor SAMUEL D. GROSS, Philadelphia.

The American Surgical Association has listened with pleasure and profit to your paper, regrets your absence, and sends the sympathy of all of its Fellows and their hope for your speedy recovery.

Edward M. Moore,
President.

Important papers were read and discussed, and on the fourth day of the meeting the following additional telegram was ordered sent:

Prof. S. D. GROSS, Philadelphia.

The Fellows of the American Surgical Association are unwilling to depart until they are able to learn whether their hope for the improvement of your health has been realized.

This hope was not to be made real, for three days later the great surgeon entered upon his long rest. His own hope had, however, been realized; the American Surgical Association which he had founded and sustained had lived and grown and become an honor to him.

It is not possible for one to study the volumes of the Transactions or the book of Minutes without feeling that the broad and lofty spirit of the Founder and his colleagues pervaded all that was done. Thus, in the presidential address of the meeting of 1885 the eminent Dr. William T. Briggs, of Nashville, said: "We may safely indulge the confident expectation that this meeting will be characterized by the spirit in which the Association had its origin, and will be pervaded by the same united purpose, the same harmonious and agreeable intercourse and similar valuable work to that which has edified and instructed us in previous meetings, and

which, in the brief period of its existence, has so illustrated the usefulness of the Association, that its permanency as an exponent of the status of American Surgery, and as a factor in the true advancement of its science and art, is fully assured."

At this meeting of 1885 the first of the foreign Honorary Fellows were elected. These were: Paget, Lister, Erichsen, Annandale, von Volkmann, von Nussbaum, von Esmarch, von Czerny, von Billroth, von Langenbeck, Ollier, and Verneuil. Of these twelve distinguished European surgeons but one, von Czerny, survives.

At the meeting of 1886 Dr. C. H. Mastin, of Mobile, proposed the union of nine of the special associations under the title of, "The Congress of American Physicians and Surgeons," and in due course of time, and largely through the patient labor of Dr. Mastin, this Congress was formed, practically under the organization which governs it to-day. No comment need be made regarding its success; once in three years we all meet, at this suitable season of the year and in this beautiful city of Washington, and I feel sure that it is both interesting and instructive for the members of the various Societies to renew old acquaintance and profit by the reports of the advances which are being made in the various departments of Medicine other than those in which they are most actively engaged.

At the meeting of 1891 a Committee on the Address of the President, Dr. Mastin, recommended: "That the President be empowered to appoint a committee with authority to confer with the friends and admirers of the late Professor S. D. Gross, and with the profession at large, for the initiation of a movement on the part of the Association, having for its object the erection of a monument to Dr. Gross, in the City of Washington." A Committee of twenty-six of the Fellows under the Chairmanship of Dr. J. R. Weist, of Richmond, Ind., who had earnestly and ably served the Association as Secretary since its foundation, was appointed to forward this project. Their labors were successful, and in 1897 the dignified statue of our Founder, suitably placed in the city in which

we are now meeting, was unveiled with appropriate ceremonies.

Allusion has already been made³ to the important meeting of the International Surgical Society which will be held during the early part of the coming year in the City of New York. We are not to forget that the original suggestion for the formation of such a Society had its inception in the mind of our esteemed Fellow, Dr. Keen, who set forth a definite design at the meeting of our Association in 1895. Although fruition did not attend this particular plan the seed which he sowed fell on good ground, and I think it quite safe to say that it indirectly resulted in the formation of the dignified international surgical body which held its first meeting in the City of Brussels in 1905.

It would be trite to dwell on the advances which have been made and which are being made in Surgery. The progress has been as constant as it has been efficient. The scholarly Cheever in his address before this body in 1889, discussing the future of surgery, gave under the heading of operations as yet *sub judice*, or on trial: Resection of the pylorus; resection of cancerous intestine, of omentum; removal of the spleen; of large bronchoceles; of the larynx; the pancreas; the prostate gland; the normal ovary; fixation of the kidney, of the uterus; puncture of the pericardium; opening gangrenous abscesses in the lungs; tapping the ventricles of the brain. It need not be said that with the exception of the removal of the normal ovary all of these are ordinary procedures of to-day and that to these fields very many others have been added. "By the work one knows the workman"; I have already said that I feel unbounded pride in the work of the American surgeons who have gone before us, or who are now, as Seniors, resting from their labors, and of those still in, and approaching, their most productive period. It has been well said that: "The achievements of its citizens are the most valuable assets of a country"; it is in a spirit far from boast-

³ See previous note regarding the omission of certain details relating to the business of the Association.

ing that I say that my fellow-members of this Association have contributed constantly and effectively to the splendid progress which has placed modern surgery among the brilliant phenomena which characterize the last quarter of a century. This sentiment, to which I give expression, is a part of myself, and the thought leads me to ask, in a tentative way, whether we have not at this time and in this country a distinctive school of surgery? Definite answer to this must be made by our colleagues in other lands, and yet, as one views and reviews the leading clinics of the United States and of Canada he feels that there are certain marked characteristics which leave their impress on the mind of the impartial observer. Can these impressions be expressed in words? Not easily, yet an attempt may be made.

One marked characteristic of our surgery would be, perhaps, a very broad spirit of catholicity and eclecticism. From the earliest days our surgeons have traveled, have studied, have gathered and brought back and placed in practice the best which they have found in other countries.⁴ This has not been mere imitation, it has been intelligent selection. Further, our students and teachers have constantly added to the fruits which they have gathered abroad. The surgery of the brain and spinal cord, of the thyroid gland, of the breast, of the abdomen—especially the regions of the appendix vermiformis, of the gall-bladder, of the stomach, of the duodenum, of the large intestine—gunshot wounds of the abdomen, the surgery of the urinary bladder, of the prostate gland, of the cardiovascular system, of the joints, to mention but a few especial regions, all bear eloquent testimony to their labors. Again, they have made a practice of journeying constantly, for surgical study and observation, in this country. The meetings of the Society of Clinical Surgery form an admirable example of this, and we have, throughout the land, centres of clinical study to which our surgeons go more and more frequently. Further, this excellent habit of study-travel affects the sur-

⁴It is not possible to in any way give adequate expression to the feeling of debt which we owe to the surgeons of other lands.

geons in the smaller towns, greatly to the advantage of both teacher and student, using the latter word in the sense that all thinking men remain students.

When we look over the list of surgical text-books published in this country we find reflected in no small degree the work and influence of the Fellows of this Association. Further, the books themselves will, I believe, bear favorably a comparison with those of other lands; their number and importance increase rapidly from year to year. Again, our surgical journals may well give us cause for pride.

In considering other salient features of our professional work I venture the thought that no men in surgery surpass ours in innate consideration for the best interests of the individual patient. Witness the care with which cases for operation are selected, witness the attention given to such important matters as anæsthesia, witness the desire for excellence in end results, witness all that makes for evenness in surgical work. The training and development of our nursing force in surgery has been no small factor in placing our surgical work where we find it to-day. Our training schools of nurses justly command the admiration of the surgical world.

Surgery with us attracts the very best of young men; young men of high ideals, of noble purposes; diligent, earnest seekers of the truth. It affords these young men abundant problems for solution, and our laboratories and wards bear testimony to the efforts which they are making. Many of these accomplished young men leave the metropolitan centres in which they have received their preliminary training and go out into the smaller cities and towns, there to develop hospitals in which much reliable work is accomplished. But I cannot refrain, at this time, from again calling attention to the absolute necessity for thorough preparation and training in surgery. Dr. Richardson made this the subject of a forceful address in 1907, an address well worth reading and re-reading, while Dr. Finney has recently emphasized the prevalence and danger of irresponsible surgery while address-

ing the Southern Surgical and Gynæcological Association. Not every man who is practising surgery to-day is worthy of the name of surgeon. Experience is still a good teacher despite the fact that aseptic technic renders many ill-considered operations comparatively safe as regards the life of the individual. There is no royal road to surgery, and the long years of apprenticeship which our predecessors underwent and which we went through are as necessary at this time as in their day and ours. It is a long step from the mere operator to the real surgeon. The pseudo-surgeon is rife in our land as in others, and he is responsible in no small degree for the growing tendency toward commercialization in surgery, that hideous monster against which our faces are so sternly set.

But I must not allow myself to digress from the central thought of my theme, pride in American Surgery, for the good so immeasurably outweighs the bad. Never was surgery so well taught in our medical schools as to-day, never were the medical schools themselves progressing so rapidly toward higher and better standards. Never before has surgical research work been carried on with such earnestness and thoroughness. Cheever, in 1889, in the scholarly address to which reference has been made, took as his thesis "The Future of Surgery Without Limit"; the same subject might well be chosen to-day and one might well make the forecast that the fields which are *sub judice*, or on trial, at this time, will have been conquered at the end of another quarter of a century. In the coming years, as in the past, American Surgeons will bear well their part, and the Fellows of this Association will carry high the banners left in trust by Samuel D. Gross and his colleagues.

This, then, is my *professio fidei*: A deep reverence for the traditions of our craft and for the traditions of this Association; a profound regard and admiration for the surgical work which has been done and which is being done in our country, and a clear and steadfast confidence in all which our surgical future may have in store.

FIBROMATOSIS OF THE STOMACH AND ITS RELATIONSHIPS TO ULCER AND TO CANCER.*

BY ALEXIS THOMSON, M.D.,

OF EDINBURGH.

Professor of Surgery in the University of Edinburgh.

AND

JAMES M. GRAHAM, M.D.

From the Surgical Department, University of Edinburgh.

WE propose in this paper to give a general account of the condition known as fibromatosis of the stomach, for it is the lesion which is most often mistaken for cancer.

We have chosen the term "fibromatosis" because it expresses the most striking feature of the lesion without conveying any view as to its nature or etiology. From the fact that we always found it associated with ulcer, "ulcer-fibromatosis" would probably be a more accurate term.

Although the condition has been known for the greater part of a century, there has always been, and there are still, the most widely divergent views as to its nature. Cruveilhier felt sure of his ground, for his paper, published in 1835, was entitled "Innocent Hypertrophy of the Pylorus." English authors, notably Brinton, who described the condition under the term "cirrhosis of the stomach" or "linitis plastica," and Handfield Jones, who employed the term "fibroid induration of the stomach," had also no doubt, it would appear, of the innocent nature of the affection. With the advent of more accurate methods of histological examination, in which German pathologists played a prominent part, there arose a confident and apparently unanimous opinion that Cruveilhier's innocent hypertrophy and Brinton's cirrhosis represented an atypical form of carcinoma.

* Read before the American Surgical Association, May 6, 1913.

We have been fortunate in acquiring a number of specimens in a good state of preservation, chiefly derived from our own clinic, but largely augmented from those of our colleagues, and we are specially indebted to Professor Caird for generously placing a number of the specimens from his collection at our disposal. Our material consists of the following specimens almost exclusively obtained from the operating theatre: Fibromatosis, 9; fibromatosis with ulcer—cancer, 5; tuberculosis with cancer, 1; cancer—specimens specially selected for examination, 35.

We do not mean to imply, because our investigations have been carried out on a larger scale than was available to those who have preceded us in this inquiry, that we have reached anything like finality on the subject, but we claim to have made a number of reliable observations. We use the word reliable with confidence, because in the examination of the more difficult specimens, we have had the advice of two expert pathologists, Dr. James Ritchie, Superintendent of the Laboratory of the Royal College of Physicians, and Mr. Richard Muir of the Pathological Department of the University of Edinburgh.¹

We believe that we are in a position to clear up, in some measure, the long-standing controversy as to whether fibromatosis of the stomach is innocent or malignant. We have found that in some cases it is innocent, while in others it is associated with cancer. The controversy owes its origin to the fact that there occurs in the stomach a diffuse infiltrating form of scirrhus cancer which in its distribution resembles fibromatosis, while at the same time it differs so much in its naked-eye and microscopic appearances from the classical forms of gastric carcinoma that its true character is not capable of being established without a thorough histological examination. The controversy has also been kept alive by the fact that when cancer involves a stomach that is already the seat of

¹ We are also indebted to Mr. Pirie Watson, M.B. and Mr. R. C. Alexander, M.B., Assistants in the Surgical Department, and to Mr. Frank Pettigrew, technical assistant in the same department, for many of the illustrations.

fibromatosis, the evidence of its presence in the stomach is not always easy to find, whereas it is readily discovered in the associated lymph glands.

Our material was prepared as follows: the resected portion of the stomach was fixed in Jeré's fluid, and after being embedded in paraffin, complete sections were cut, stained for the most part in hæmatoxylin and eosin, and mounted for examination under a low power of magnification. These large sections enabled us to study the distribution of the disease and the gross changes in the different coats of the stomach at different levels. Small portions of tissue selected from different parts of the specimen were cut and stained for examination with higher powers, in order to observe the nature of the cellular elements and the minute changes in the tissues.

Fibromatosis of the Stomach.—The condition may be limited to a portion of the stomach, the localized form, or it may extend throughout the entire stomach, the diffuse form. The localized form is not only the more frequent, but it is the form which, from the clinical point of view, is the most important to differentiate from cancer.

The Localized Form of Gastric Fibromatosis.—It nearly always commences in the vicinity of the pylorus and spreads from there toward the cardia, usually, but not always, showing a preference for the lesser curvature.

External Appearances.—There is a sharp contrast between the affected pyloric portion and the rest of the stomach; the latter is flaccid and collapses readily, whereas the affected portion is rigid, densely hard like gristle; the peritoneal surface, when free from adhesions, is white, pearly, and smooth. While this external appearance resembles cancer, it may be said that fibromatosis forms a flattened, smooth-surfaced tumor, whereas a cancerous tumor tends to be more rounded in shape, and is often nodular on the surface; this distinction, however, is so general that it cannot be depended upon. There is an absence of the cicatricial contraction that is so common a sequel of uncomplicated chronic ulcer, and

there is no suggestion of cicatricial stenosis of the pylorus or of hour-glass contraction of the body of the stomach.

The glands along the curvatures, especially the lesser, are usually enlarged and firmer than normal, again suggesting cancer, but there is a greater tendency for them to retain their normal shape than is usual when they are infected with malignant disease. It goes without saying that we are not here considering advanced cases of malignant disease in which the appearance of the stomach and of the adjacent parts render the nature of the condition unmistakable.

Reference should be made to those cases of fibromatosis in which, when the abdomen is opened, the pyloric end of the stomach is found to be so buried in adhesion, matting it to the surrounding organs and to the omenta, and it may be also to the parietal peritoneum, that a satisfactory examination of the stomach is impossible; we believe that these represent the type of case in which either nothing can be done in the way of a curative operation, or at the most a palliative gastro-enterostomy or jejunostomy, and the patient, in spite of a gloomy prognosis, makes an unexpected and permanent recovery.

Changes in the Coats and in the Interior of the Stomach.—

The pyloric portion of the stomach is converted into a rigid, funnel-shaped tube, the lumen of which is greatly contracted. The increase in the thickness of its wall is remarkable; in some of our specimens it measures 2.5 cms.

In the majority of the specimens we have examined (7 out of 9), there is situated, in about the centre of the affected area, a deeply-punched-out ulcer; the surrounding mucosa, instead of being as soft as velvet, freely movable on the subjacent coats, and showing prominent rugæ, is firm and unyielding, is closely adherent to the submucosa, and presents a hillocky surface, corresponding to variations in thickness of the fibromatosis in the submucous coat. The altered appearance of the interior stops abruptly at the pyloric ring, while toward the cardia it gradually merges into the normal, in other words, there is no ridge at its margin. In

one case the appearances are especially characteristic; there is a large, deep ulcer occupying the greater curvature about three inches from the pyloric ring; in the area of the ulcer all the coats have disappeared, its floor being formed by a layer of dense scar tissue, while over the fibromatosis in the submucosa which extends round the remainder of the circumference, the mucosa is adherent and undulating, and appears thicker than normal. In two of our specimens, there is no visible punched-out ulcer, but the mucosa, over the submucous fibromatosis, presents a smooth, atrophied appearance, which microscopical examination shows to be due to a superficial form of ulceration combined with fibrosis. The undulating, hillocky appearance of the interior of the stomach is sometimes exaggerated so that there are eminences separated by deep clefts; the mucosa then presents a polypoidal appearance, and we think that it is probable that some of the specimens described in the literature and in museum catalogues as "polyposis of the stomach" may be examples of fibromatosis of the submucous coat, in which the contraction of the newly-formed fibrous tissue has caused the mucosa to project in the shape of polypoidal masses into the interior of the stomach.

The Presence of Ulcers and of Ulceration.—We devoted special attention to the condition of the mucosa of the stomach as we early suspected that a breach of surface of the mucosa would prove to be an antecedent of fibromatosis. We should like to restrict the term "ulcer" to the well-known punched-out defect in the coats of the stomach, easily seen with the naked-eye, and employ the term "ulceration or erosion" when the mucosa looks thin and wasted, and microscopical examination shows a partial disappearance of the glandular elements on the free surface, associated with chronic inflammatory changes in the interstitial tissue.

In nine specimens of fibromatosis limited to the pyloric end of the stomach, no less than seven showed a visible punched-out ulcer, situated, roughly speaking, in the centre of the affected area; in the remaining two specimens there was

superficial ulceration over the greater part of the affected area. In the majority of cases, the punched-out ulcer had spread through all the coats of the stomach.

The Submucosa.—From being a thin, loose layer of areolar tissue supporting the larger blood-vessels and allowing the mucosa to move freely on the muscularis, it is converted into a thick, solid, tough white tissue, not so dense as keloid but resembling the consistence of a hard fibroma. It varies in thickness from .2 cm. to 1.2 cm. in different specimens and in different parts of the same specimen; in some cases it constituted $\frac{7}{8}$ of the entire thickness of the gastric wall. On the cardiac side the fibromatosis tapers off gradually; on the pyloric side, it stops abruptly, usually at the pyloro-duodenal junction.

There is no difficulty in differentiating the fibromatosis from the scar tissue which frequently accompanies chronic ulcer, for, unlike scar tissue, it is uniformly distributed throughout the submucous coat, whereas, when the coats of the stomach are replaced by scar tissue, all traces of the original arrangement is lost.

The Muscularis.—The muscularis is very commonly the seat of a *marked hypertrophy of the circular fibres*, this being a response to the increased strain upon the organ in forcing its contents through the narrowed pylorus. In the rare cases in which the pylorus is not involved by the fibromatosis, this hypertrophy is absent. Hypertrophy of the circular fibres is usually sufficiently marked to be easily seen with the naked eye. The hypertrophy of the muscle is most marked near the pylorus, and tails off gradually toward the cardia.

More characteristic, however, than the hypertrophy, is the *segmentation of the circular muscle*, which is divided up into bundles by partitions or septa of white fibrous tissue continuous with the fibrillated tissue of the submucosa. The brown color of the muscle renders this segmentation very obvious to the eye. Hypertrophy of the circular muscular coat is a common accompaniment of cancerous obstruction at the pylorus, and it may be quite as marked as in the stenosis due

to fibromatosis, but, so far as we know, it never shows the same degree of segmentation, and we have therefore come to regard it as a characteristic feature of fibromatosis. There is rarely any change in the longitudinal bundles of muscle.

The *subserous and serous coats* are little altered as a rule, but in some cases, they also are invaded by the fibromatosis and become correspondingly thickened.

The Pylorus.—*Narrowing of the pylorus* is almost a constant accompaniment of fibromatosis, and it may reach an extreme degree. It is chiefly due to the increase in thickness of the submucous coat, but it is also contributed to by the contraction of this coat whereby the mucous membrane is projected into the lumen, often in the form of folds or polypoidal eminences. The function of the pylorus as a channel of exit for the gastric contents is further impaired by the unyielding character of the tissue forming its wall.

When the fibromatosis extends to the pyloro-duodenal junction, and this is looked at from the duodenal side, the mucosa is seen to project as a collar-like ridge, and the pyloric aperture is reduced to a narrow slit, which presents variations according to the distribution of the lesion. As in the hypertrophic stenosis of infants, this appearance has been likened to that of the os uteri, but the comparison is less apt in the case of fibromatosis, as the opening rarely occupies the centre of the channel.

Microscopical Appearances.—Those necessarily vary at different stages of the process.

Histological Changes in the Mucosa.—Reference has been made already to the invariable presence of a visible ulcer or of ulceration in the mucous membrane. We shall here describe the changes seen with the microscope. Many of the specimens show increase in thickness of the mucosa, this sometimes amounting to three times the normal thickness. Some of this thickening appears to be due to contraction of the submucous coat, crowding the mucosa into a smaller area, but it is chiefly due to actual increase in the amount of the

interstitial tissue. In some specimens this interstitial change is very pronounced, a thick layer of chronic inflammatory tissue elements separating the secreting tubules from the muscularis mucosæ. More frequently the new tissue separates the tubules from each other, compressing them and causing their gradual disappearance. In the progressive replacement of the tubules by young fibrous tissue there are appearances which might at first sight be mistaken for cancer; an attenuated tubule without a lumen may appear on transverse section like an alveolus filled with cancer cells, but further examination shows the continuity of the tubule with one opening on the surface and, further, that all the epithelial elements are superficial to the muscularis mucosæ. Some tubules show cystic dilation, others show remarkable elongation. Although there is no evidence of active mitosis or of proliferation of the epithelial cells, these changes might reasonably be regarded as precancerous in nature.

The muscularis mucosæ is in some cases involved in the fibrosis, that is, the muscle fibres are separated by young fibrous tissue.

The cellular infiltration, which is the main cause of the thickness of the mucosa, is composed mainly of small lymphocytes and plasma cells, with, in addition, a large number of proliferated endothelial cells and fibroblasts in an early stage of development. Some large phagocytic mononucleated cells are also present. There are no polymorpholeucocytes.

These chronic inflammatory changes in the mucosa are associated with ulceration on the free surface and loss of the covering columnar epithelium. It is noteworthy that this superficial ulceration is less in evidence in these specimens in which there is a visible punched-out ulcer; in the case already referred to on page 14, in which there is a large, chronic ulcer at the greater curvature, and a submucous fibromatosis in the remainder of the circumference of the stomach, the over-lying mucous membrane is intact. We feel warranted

in making the inference from this observation that the changes seen in the mucosa in other specimens are primary in character. Were they secondary to, and a result of, the submucous fibromatosis, they would have occurred in this specimen. Our view is that the changes in the mucosa, particularly the ulceration, are primary, and are followed by the fibromatosis in the submucosa.

Histological Changes in the Submucosa.—In the fully-developed condition, the submucosa is represented by a thick, uniform layer of fibrillated connective tissue. The fibres are not arranged on a fixed plan as in a tendon, but, although in parts parallel, they mostly run in all directions as they do in a fibroma or in other forms of fibromatosis, *e.g.*, neuro-fibromatosis.

The connective tissue cells are scanty and are flattened between the fibres. Here and there are collections of lymphocytes in the vicinity of the muscularis mucosæ. There are numerous well-formed blood-vessels, presumably belonging to the original submucosa, and in addition there are a number of capillaries, more than was to be expected in view of the bloodless condition of the tissue as seen with the naked eye. There is a complete absence of endarteritis.

We are unable to confirm the observation that the fibrous elements of the submucosa undergo hyaline degeneration.

The scar tissue associated with ulcer, in contrast to fibromatosis, takes on more of the hæmatoxylin stain, the fibres do not present any regularity in their arrangement, the connective tissue cells are more numerous, and the tissue elements in the fully evolved condition, both fibres and cells, are more closely packed and are less vascular.

Histological Changes in the Muscularis.—The changes observed in the muscle are mainly those of hypertrophy. In the early stages of fibromatosis, separation of the muscle bundles is confined to the inner layers of the circular coat. In well marked cases the fibromatosis extends throughout the circular coat and may also affect the longitudinal coat al-

though never to the same degree. The condition might be described as a coarse cirrhosis in which the muscle bundles are separated by fibromatosis which is continuous with and of the same character as that in the submucosa. At the same time small fasciculi and even individual muscle fibres are occasionally seen in the midst of the fibromatosis. The muscle fibres show no signs of degeneration; they appear capable of functioning and the only change observed is an increase in the number and in the length of the nuclei.

Cases of Fibromatosis Associated with Ulcer-cancer.—The combination of ulcer-cancer with fibromatosis is especially difficult to identify without detailed microscopical examination. In one of Mr. Caird's specimens the chronic ulcer is situated 6 cm. from the pyloric ring; on either side of it, the coats of the stomach are invaded and in parts replaced by an actively growing spheroidal-celled cancer, while beyond the limits of the ulcer there is a well-marked fibromatosis of the submucous coat with hypertrophy and segmentation of the muscularis.

In one of our own cases there is superficial ulceration of nearly two-thirds of the circumference of the pyloric segment of the stomach; in the remainder, the mucosa is irregularly thickened, and at one point, only to be seen with the microscope, there is the earliest visible stage of the invasion of the submucous and muscular coats, by a spheroidal-celled cancer. The fibromatosis is moderate in degree and its distribution closely corresponds to the ulcerated area in the mucosa. In another of our cases there is a punched-out ulcer about one inch from the pyloric ring, the floor of which consists of a mass of scar tissue replacing all the coats. At the edge of the ulcer, the scar tissue is being invaded by an extensive growth of cancer—a condition which is not appreciated by the naked eye—while beyond this there is a comparatively limited amount of fibromatosis.

In a fourth case there is an ulcer close to the pyloric ring, with marked fibromatosis both in the submucous and sub-

serous coats, and an early adenocarcinoma proceeding from the edge of the ulcer and invading the submucous and muscular coats.

In the fifth case, for which we are indebted to Mr. Cathcart, there is in the centre of the fibromatosed area a deeply punched-out ulcer, which has eaten through all the coats; we failed to find evidence of cancer in the different portions of stomach submitted to microscopical examination, but this was readily found in an enlarged lymph gland, embedded in the fat of the lesser omentum.

The comment on this series of cases is that they all illustrate the same sequence of events. Following upon a chronic ulcer, attended with fibromatosis, there occurs an epithelial growth at the margin of the ulcer, and an invasion of the deeper coats of the stomach. It should be emphasized that, excepting the first of the five, there was nothing in the naked-eye appearance to suggest the presence of cancer.

Pathogenesis of Gastric Fibromatosis.—Gastric fibromatosis, in view of its selective and spreading characters, suggests an analogy with the fibromatosis of nerves—neurofibromatosis—but the analogy goes no further; we have examined the stomach from a case of generalized neurofibromatosis in our own collection, and we find that the submucosa is not appreciably altered and that the fibromatosis mainly involves the nerves of the muscular and subserous coats.

We have not observed any features that would suggest the view advanced by some writers that the lesion is of syphilitic origin; there is no characteristic granulation tissue and there is an entire absence of endarteritis, and in the cases in which we have had an opportunity of employing the Wassermann reaction, the results have been negative. We do not mean to deny the occurrence of a gummatous lesion of the pyloric portion of the stomach, causing stenosis of the outlet, such as has been described by Bird of Melbourne (B.M.J., Oct., 1910), but we have not met with the condition.

We are also disinclined to accept the view that fibromatosis

is due to a tuberculous infection. We have had the opportunity of examining a specimen of Mr. Caird's which presents a combination of tuberculosis and cancer; the tuberculous granulation tissue, which shows typical giant-celled systems, is most abundant in the subserous coat. The suggestion that fibromatosis represents an attenuated form of tuberculous infection, in the sense propounded by Poncet and other members of the Lyons School, is not supported by our observations.

The most widely accepted view regarding the nature of the thickening in the submucous coat, which we have called a fibromatosis, is, that it is really a form of atrophic infiltrating scirrhous carcinoma. We would like to point out that we are familiar with this form of cancer in the stomach, and we recognize also that it may cause a diffuse thickening of the submucosa, which, to the naked eye, may be indistinguishable from the condition we call fibromatosis. The investigation of our material, in the light of this knowledge enables us to affirm most positively that fibromatosis may occur without the presence of cancer.

The Association of Fibromatosis with Ulcer or Ulceration of the Mucosa.—Having succeeded, as we believe, in establishing fibromatosis as an innocent affection of the stomach, we shall now consider the conditions under which it occurs. The most striking association is that which exists between fibromatosis and ulcer or ulceration of the mucosa.

The apparently invariable association of fibromatosis with ulcer or ulceration of the mucosa raises the question, is fibromatosis a primary change in the stomach or is it secondary to an antecedent lesion? We have never seen fibromatosis in a stomach that was otherwise normal. When fibromatosis is associated with a punched-out ulcer, the mucosa over the surrounding fibromatosis may be practically normal; this would appear to warrant the inference that submucous fibromatosis is not the cause of the changes in the overlying mucosa, but that these precede the fibromatosis and are probably related to it as cause and effect. In other words, the

changes in the mucosa are primary and the submucous fibromatosis is secondary.

The lesion of the mucosa that is followed by fibromatosis is either a punched-out chronic ulcer or a chronic superficial ulceration; this naturally suggests that the necessary antecedent of fibromatosis is a breach of the surface, which permits of the access to the subjacent submucosa of a toxin or irritant, to which the tissue of the submucosa reacts, and the reaction takes the form of a diffuse, spreading, new formation of young fibrous tissue. The diffusion or spread of the fibromatosis in the submucosa, from its original seat of formation, its abrupt arrest at the pyloric ring, its extension mainly along the lesser curvature, its extension into the muscularis between the bundles of circularly disposed muscular fibres, all agree in supporting the view that the irritant which causes fibromatosis is conveyed from its entrance to the parts which react to it, by way of the lymphatics.

The capacity of spreading diffusely is one of the most suggestive features of fibromatosis, and is naturally one of the explanations of its having been regarded by many observers as an infective or malignant disease.

It is instructive to contrast fibromatosis with other forms of connective-tissue reactions resulting from irritants. It is obviously a form of "chronic inflammation," but it differs essentially from those which are familiarly known to us. Contrast it, for example, with the scar tissue in the fibre and margin of a chronic ulcer; scar tissue replaces the coats of the stomach, it shows no predilection for any one of them; it is confined to the immediate vicinity of the ulcer, and its naked-eye and microscopical appearances do not differ from those of scar tissue in any other tissue or organ of the body.

The same contrast holds good with the new formation of fibrous tissue, in response to irritation, seen, for example, in chronic lesions of the gall-bladder or of the urinary bladder. There may be great thickening and induration of the wall of either viscus, but there is no selective fibromatosis of any particular coat.

It is also instructive to contrast fibromatosis with the well-known forms of chronic interstitial fibrosis or cirrhosis which occur, for example, in the liver or kidney. In these, the new formation of fibrous tissue affects the whole connective tissue frame-work or stroma of the organ, and is diffuse from the outset, presumably because the irritant causing it is conveyed by the blood stream; in gastric fibromatosis, the new formation of fibrous tissue commences in the vicinity of a breach of surface in the mucosa, and selects the submucous coat, as if the irritant were slowly diffused along the lymphatics.

Considering the frequency of duodenal ulcer, it is remarkable that there is no record of fibromatosis similar to that met with in relation to gastric ulcer; this, together with the fact, that, duodenal ulcer is practically immune to the incidence of cancer, inclines us to conclude that there is some peculiarity in the pyloric portion of the stomach which renders it liable, both to ulcer-fibromatosis and to ulcer-cancer.

Relationships of Fibromatosis to Cancer.—We have sufficiently elaborated the proposition that fibromatosis is not cancer, and we believe we have proved that it may occur apart from cancer. There remains, however, the very important observation, that the ulcer which is complicated by fibromatosis may also become the starting point of cancer, and we have been able to record the details of five cases which illustrate this combination of lesions. Our observations suggest, that the ulcer is the primary lesion, that the ulcer is followed by fibromatosis, and that, finally, a cancer originates at the edge of the ulcer. The epithelial proliferation, being walled in by the dense scar tissue around the ulcer, and by the scarcely less dense fibromatosis in the surrounding submucosa, is greatly hindered and makes little headway, so little that it is difficult to recognize it except on careful microscopical examination. Cancer cells escape into the lymphatics from time to time and, when they have reached the adjacent lymph glands, are identified in these more easily than in the primary focus.

The type of cancer is either an adenocarcinoma or a spheroidal-celled cancer.

Clinical Features of Ulcer-Fibromatosis.—Inasmuch as fibromatosis is always a sequel of peptic ulcer or ulceration the clinical features are practically those of ulcer, and they are influenced to a greater degree by the seat of the ulcer than by its association with fibromatosis. In the exceptional cases, in which the pylorus is not involved the symptoms are inconclusive; indigestion and epigastric pain of some months duration, such as would not have suggested operative interference but for the recognition of a palpable tumor, which was diagnosed as cancer.

In the cases, in which the pylorus was involved, the symptoms were those of pyloric obstruction; and as in the majority there was an absence of free hydrochloric acid, along with a palpable tumor, the diagnosis of cancer was made with confidence. Hemorrhage was a prominent feature in only one case, although there was an ulcer or ulceration in all the cases. The discovery of a tumor in the epigastrium, sometimes made by the patient, occurred in a larger percentage of the cases than is usual in cases of ulcer uncomplicated by fibromatosis. The sexes were affected in approximately equal proportion.

The Recognition of the Nature of the Tumor When Exposed by Operation.—In the great majority of cases in which the abdomen is opened and a tumor of the pyloric segment of the stomach is rendered available for examination, it is possible to make a reliable diagnosis as to its nature. The clinical history, the tests of the gastric functions, and the radiographic appearances, together with what one can see and feel, will enable the operator to come to a decision as to the nature of the lesion. And yet, with all these data to go upon, the operator has been wrong in his decision in no less than nine of the cases recorded in this paper. It is easy, in the light of after events, to explain these diagnostic errors. The operator has been led to expect the existence of a pyloric carcinoma; on opening the abdomen, he finds a tumor involving the pylorus, obstructing the pyloric outlet, spreading

along the lesser curvatures, and associated with enlargement of the lymph glands in the lesser omentum. He naturally regards the diagnosis of carcinoma as confirmed, and he proceeds to resect the stomach. Supposing, however, the operator has been deceived in previous cases and insists on immediate microscopical examination of a portion of the tumor or of one of the enlarged glands. The examination of one of the lymph glands is the most easily carried out and also, the most instructive. If it is found to show cancer, no further doubt is possible, but, and this is our point, if cancer is not found, the question is by no means solved. A positive result is conclusive, but a negative one is of little value. The more we have studied this question of immediate microscopical examination the less are we prepared to rely upon it. In several of our specimens we have been obliged to cut sections from different parts of the tumor and from several of the enlarged glands related to it, and instead of the few minutes implied in the term "immediate microscopical examination," prolonged and repeated efforts were required before the question of innocence or malignancy could be decided with any approach to certainty. The suggestion that a surgeon should delay the important steps of the operation until he has been informed of the results of the histological investigation conveys a confidence in rapid microscopical diagnosis which we regret we are unable to share.

Inspection of the interior of the stomach may help in a limited proportion of doubtful cases. A projecting cauliflower growth, for example, establishes the diagnosis of cancer; the absence of such a growth, however, does not exclude cancer. The discovery of a chronic ulcer, without infection of glands, would justify the operator in performing a limited resection instead of the radical operation for cancer.

Operative Treatment of Gastric Fibromatosis.—If we suppose that the condition has been correctly diagnosed and that the existence of cancer has been excluded, we advise that the affected portion of the stomach should be resected, because of the undoubted risk of cancer supervening.

Suppose, further, that it has not been possible to exclude the presence of cancer, and we believe that this is a more common condition of affairs, then again, we say resect. A reasonable alternative, and one we have ourselves practised, especially in weakly patients, is to perform a gastro-enterostomy and at the same time remove several of the enlarged glands from the lesser curvature. If these show the presence of cancer, the resection should be carried out after a suitable interval for recuperation. Further, if the disease, not diagnosed with certainty either as cancer or ulcer-fibromatosis, does not lend itself to radical operation, then relief to the symptoms should be afforded by gastro-enterostomy, and, if this is impracticable, by jejunostomy. Eiselsberg records a case of fibromatosis of the pyloric segment, treated by jejunostomy and the patient was in good health six years after the operation.

The Diffuse Form of Gastric Fibromatosis or "Leather-Bottle" Stomach.—In the classified work by Brinton on diseases of the stomach, it is taken for granted, that the diffuse form of the lesions, is, like the localized variety, innocent in character. We confess that at first we shared this opinion but we are now convinced of the unreliability of our observations owing to the imperfect preservation of the specimens of "leather-bottle" stomach in the University Museum. We have only been able to examine (and that owing to the kindness of Dr. Drennan) one first specimen of the lesion; sections taken from different parts of the stomach and from the glands, show a diffuse form of carcinoma.

We do not think the observations recorded up to now are sufficient to decide the question. We think it is probable that an innocent form of "leather-bottle" stomach does occur; we are not surprised, however, that it is rare, because the spread of the disease throughout the stomach affords ample time for the superaddition of cancer and because the patient is liable to succumb to the localized form of the disease before it has had time to become diffused, or he is relieved of it by the surgeon.

DIAGNOSIS AND TREATMENT OF FRACTURES INVOLVING THE KNEE-JOINT.

INCLUDING EPIPHYSEAL SEPARATION.

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WE have for consideration lesions affecting three bones,—the patella, the tibia and femur.

THE PATELLA.—*Number.*—In 1906, Dr. David Scannell published a valuable paper upon compound fracture of the patella,¹ which included a tabulation of all fractures in the Boston City Hospital in forty-two years. According to this tabulation there were during this period 38,627 fractures of all kinds, of which 660 were closed and 8 open (compound) fractures of the patella. A careful examination of the records from January, 1906, to May 1, 1913, reveals 211 simple and 3 open patella fractures in addition, so that from May 24, 1864, to January 1, 1913, there have been a total of 871 simple, and 11 open fractures of the patella treated at the Boston City Hospital.

Frequency.—Scannell compared his figures with those of Gurlt (Hamburg, 1862) who reported 51,938 fractures from London hospitals. This author found that fracture of patella constituted 1.27 per cent. of all fractures. Stimson, 1912, in 14,566 fractures at the Hudson Street Hospital, New York City, found 183 fractures of the patella, or 1.26 per cent. Scannell found the per cent. to be 1.9 per cent. and it is probable that the relative frequency of this fracture has slowly increased, so that it now forms distinctly more than 2 per cent.

* Read before the American Surgical Association, May 6, 1913.

¹ Comp. fract. patella. Report of unusual case. Tabulation of all fractures in Boston City Hospital in 42 years. David D. Scannell, M.D., Boston Med. and Surg. Jour., Nov. 15, 1906.

of the fractures occurring in Boston, and presumably throughout the United States.

Etiology.—More and more has it become evident that the cause of this fracture is muscular, or indirect violence, in the large majority of cases. The fact that only 11 of 882 cases were open fractures argues strongly for this view, because it is highly improbable that if direct violence were the frequent cause, open fractures would be so rare (but little more than 1 per cent. of all patella fractures). The writer has been impressed by the fact that the amount of muscular violence required to fracture the patella may be apparently slight, and it may be part of some action habitually performed by a healthy man. For instance (personal knowledge), three cases have occurred in athletes in the customary preliminary effort of turning a somersault. A majority of patients, however, believe that the patella is broken by the direct violence of the fall, and only by careful questioning is the accurate history obtained.

Symptoms.—Muscular violence of course produces the transverse or tear fracture, with considerable separation of fragments; indirect violence results in the comminuted or multiple fracture, often with little, occasionally (if a strong prepatellar bursa remains intact) with no separation. In this latter class of cases mistakes may be made, since the typical signs, including crepitus, separation of fragments, loss of function, may be absent. One sign, however, is always present, an increase in the intra-articular fluid, either synovia or blood or both, obliterating the normal hollows or dimples of the joint. In any acute traumatic synovitis, therefore, fracture of patella should be suspected, and positively ruled out before establishing treatment and giving prognosis.

Treatment.—Of 418 cases treated since 1895, 245 have been operated upon and 173 treated expectantly. The percentages of cases subjected to operation grows rapidly in recent years: 13 cases were admitted from January 1 to May 1, 1913, and every one has been sutured. In the early years, drilling the fragments and wiring was the routine pro-

cedure. At present, though details vary with the large number of surgeons, suture with catgut or kangaroo is the rule. In the records of fifteen and twenty years ago there are frequent references to secondary operation for the removal of wire, though the results on the whole were very good; patients were kept in the hospital almost twice as long as at present; in 1895 and 1896 the duration of hospital treatment was from six to ten weeks, at present it is less than half as long.

Refracture.—Since 1895, only seven cases of refracture have been found in the records, and four of these are within the past year, the other being much earlier. Unquestionably the tendency to limit the stay in the hospital has diminished the enforced idleness of the patient, but undoubtedly the present tendency is to let the patients leave the hospital a little too early. A sutured patella will not stand a sudden strain four weeks after the operation and refracture will inevitably occur in a certain number of cases, if patients are discharged under conditions which favor carelessness and permit accident.

In one of the four recent refractures, the condition was open, though sustained seven weeks after the original operation. Precise conclusions as to liability of refracture in operated as compared with non-operated cases are not possible, since the number is too small, but the writer believes that the chance is about an even one, the operated cases being, perhaps, a trifle more liable to refracture. In a series of cases reported in England some years ago, the conclusion drawn was that bony union in fracture of the patella does not lessen the chance of refracture, and bony union occurs only as a result of operation, except in very rare instances.

Death.—It was a surprise to find that there were no less than six deaths due either to delirium tremens (4) or to pneumonia (2) in the series of 418 cases since 1895. Of these one died of pneumonia after operation; one of delirium tremens after operation (the writer's case). The four others were treated without operation; one died of pneumonia and

three of delirium tremens. Still another patient developed severe and long-continued delirium tremens while in the hospital, but eventually recovered. There were two deaths from causes other than these, so that the total mortality was 8 in 418 cases, or nearly 2 per cent.

The writer's fatal case above mentioned was a middle-aged sailor noted to be nervous and tremulous at entrance. His condition improved, and seemed normal on the tenth day, when suture was performed. Immediately tremor returned and again disappeared, only to develop once more on the tenth day after operation. The wound was clean, the joint normal, and the skin sutures had been removed; he passed into stupor and died five days later. Autopsy was not permitted. This death is not to be attributed to the operation for fracture of the patella, but to a mistake in surgical judgment in instituting any surgical procedure of whatever nature. It is possible that the man would have died even without operation, as did the four others.

The writer, in common with many others, has passed through the period of drilling fragments, and using wire. Since the publication of Dr. Joseph Blake's paper in 1904, however, his classification and technic have been adopted and modified little if at all. The treatment is based upon the assumption that the condition is more a rupture of a tendon and a joint capsule than a fracture of a bone. In the writer's own series of some thirty cases, operation has been performed on the seventh to tenth day. Preliminary injection of the joint practised by Dr. Murphy has not been done, the tear in the lateral capsule is closed with interrupted sutures of No. 2 plain catgut, after all clots have been removed from the joint, using for this purpose instruments, not gauze; the torn periosteum is lifted from between the patellar fragments and sutured across the line of fracture, after a half purse string suture placed at either side of the patella has closely approximated the fragments; silkworm gut sutures close the skin tightly, and without drainage; a padded ham splint is applied, and the leg elevated; stitches removed from the skin on the

tenth to twelfth day. At the end of two weeks gentle lateral motion of the patella is made; passive flexion of knee through a small arc in three weeks; gentle active motion of knee in four to five weeks; patient discharged in four to six weeks, to wear splint until eight weeks after the operation. It is expected that if these directions are carefully followed, the patient should be at work in or within three months, with a strong knee and from 60 to 90 degrees flexion.

In one case a much less satisfactory result is known to have followed operation, because the patient, a very nervous young woman, could not be made to bend her knee or use her leg; at three months she had less than 20 degrees flexion; she then accidentally struck the knee against a sharp object, and fearing refracture, again refused to use it. At length, after active massage was insisted upon and vigorously instituted, she began to gain and when last seen had about 50 degrees flexion and a useful leg. Such unwillingness to bend the knee, a not infrequent occurrence, is one of the most effective causes of inadequate results, and is not easy to overcome; it emphasizes the importance of careful treatment after the patient has left the wards, a thing not always easy to compel in the careless modern city dwellers.

Open Fractures.—Of the eleven cases since 1864, eight reported by Scannell and three since his publication, only four (Scannell 1, Blake 1) have been entirely without infection; two were slightly and superficially infected; three moderately, though not harmfully infected, and two seriously infected. One of the very early cases (1889) died of delirium tremens two weeks after operation (this is not included in the cases of death described above).

One of the writer's two cases of refracture was open; the patient celebrated his discharge by getting drunk, seven weeks after the original operation; he fell down stairs; was brought to the hospital with the wound torn wide open, the fragments separated at least three-quarters of an inch, and the joint full of blood clot and dirt. The skin was scrubbed and cleansed with excessive thoroughness, and the joint irrigated

with gallons of hot salt solution, the capsule then closed as at the previous operation, and the skin sutured tightly. The convalescence was absolutely normal without the slightest rise of pulse or temperature. The result at the time of discharge from the hospital was as good as that of the closed fractures after operation, and this is true of the other open fractures in which there was little or no suppuration.

EPIPHYSEAL SEPARATION OF (a) FEMUR; (b) TIBIA.

(a) *Femur*.—Drs. Binney and Lund have just finished a careful and complete paper, based upon a study of all cases of separation of the lower epiphysis of the femur recorded in the Boston City Hospital since 1898. The paper is about to be published and the authors have kindly permitted me to summarize some of their findings.

Eighteen cases, from six to nineteen years of age, were admitted to the hospital since 1898. Of these, 13 were simple, and 5 open or compound; hyperextension was the cause in almost every instance, the exceptions being direct violence; 14 were injured in wagon accidents, no less than 7 having the leg caught in the spokes of the revolving wheel; the deformity varied from a very slight, to an extreme degree, in one case the diaphysis projecting four inches through the popliteal space. In 16 cases the epiphysis was moved forward, in two the displacement was lateral. In a majority of instances the reduction of deformity was easily accomplished under ether; in 6 cases the reduction was either difficult, or recurred, requiring repeated manipulations; in 2 cases, serious deformity persisted in spite of every effort; one case (open) came to amputation on account of interference with the circulation by pressure of lower end of diaphysis upon the vessels; one (open) was complicated by infection with gas bacillus, the leg being saved but with poor result owing to recurring forward displacement of the epiphysis. In one the recurring deformity was overcome by open operation and fixation with a wire nail driven through the external condyle into the

epiphysis, with a perfect result. The method of maintaining position after reduction was (1) simple fixation on ham splint or in plaster; (2) fixation in moderate, occasionally in extreme, flexion. Operation (a) suture of periosteum; (b) fixation by nail.

Screws, plates, and mechanical devices are reported to have been used by others, but it is obvious that they should be avoided except as an absolutely last resort, and should always be removed as soon as union is firm. The results at the time of leaving the hospital were remarkably good, considering the severity of the conditions; position must of course be controlled by frequent X-rays; the knee-joint was, apparently, not permanently affected in any of the cases.

While examining the records I have found two additional cases of separation of the femoral epiphysis, in which the index diagnosis was misleading; one complicated a very severe fracture of the midshaft of femur, in a boy of twelve; in this instance the displacement was slight and the ultimate result good. The second was at first considered a fracture, but careful X-rays showed it to be a dislocated epiphysis, in front of femur. Three efforts at manual reduction were ineffective, and open operation was necessary. This makes a total of twenty of these cases.

(b) *Separation of Upper Epiphysis of Tibia.*—This condition, recognized and described as a separate entity, is found only twice in the City Hospital Records. It seemed inexplicable to the writer, until he was informed by Dr. James Stone, that not a single instance is recorded in the Records of the Boston Children's Hospital. Conversation with other surgeons lends authority to the statement that separation of this epiphysis is extremely rare indeed; apparently violence which might be expected to produce it, in reality acts upon the lower end of the femur and its epiphysis, the tibia remaining uninjured, unless a true fracture results. In the two cases treated at the City Hospital the displacement was slight, and fixation gave excellent results. While examining X-ray plates of the knee, the writer discovered two previously unrecognized

cases of the condition first described by Osgood, of Boston, in 1903,² and now called the Osgood-Schlatter disease. It is a partial or complete separation of the tubercle of the tibia, occurring in youth. Osgood points out that while the upper tibial epiphysis includes in an anterior lip the tubercle of the tibia, the latter sometimes has a separate centre of ossification; the patella tendon inserts into this tubercle, though the tendon has accessory lateral bands going to the sides of tibia. The first pull of the powerful quadratus femoris muscle, however, is delivered upon the tubercle, and at times separates it completely, at times lifts the lower extremity partially away from the shaft. The two Boston City Hospital cases occurred in boys of 11 and 14 years and were said to be due to a fall or the effort to prevent a fall. There was local tenderness and the question of incipient bone disease, or of a fracture. The degree of separation was slight, but taken in connection with the history and symptoms, leaves little doubt of the character of the lesion. Rest and fixation are indicated, operation is very rarely needed, and results are good.

The records also contain four cases of epiphysitis of the head of the tibia, in which trauma apparently played a part. It is possible that a separation may have been the original condition in some of these. One suppurated, and was operated, but eventually died; a second was operated and recovered; the others recovered without operation.

(c) *Fracture of the Head of the Tibia into the Joint.*—This lesion is much more common than the separation of the corresponding epiphysis, but less common than a corresponding fracture of the lower end of the femur.

A recent law suit in Massachusetts called attention to the fact that this high fracture of the tibia may easily be overlooked by excellent general practitioners. In the case in question the injury, a fall from a step ladder, was treated as a severe contusion and sprain of the knee. Limitation of motion, together with continued swelling and tenderness of

² Lesions of the tibial tubercle occurring during adolescence. Robert B. Osgood, M.D., Boston Med. and Surg. Jour., Jan. 29, 1903.

the joint, caused the patient after some weeks to go to a hospital, where the X-ray showed a fracture of the outer tuberosity of the tibia, united in fairly good position. Whether a better result could have been obtained if the diagnosis was correctly made in the beginning, is an open question. In the past year two cases have been admitted to the writer's service as rupture of the internal lateral ligaments of the knee, in both of which a fracture of the inner tuberosity could be determined by careful examination; crepitus was not obtained, but slight mobility and exquisite tenderness below the insertion of the lateral ligament made the diagnosis probable before confirmation by the X-ray. Just as the sprain-fracture at the ankle-joint is more frequent than was formerly supposed, so the rupture of the lateral knee ligament is very apt to carry with it a larger or smaller fragment of the head of the tibia. Repeated X-rays are necessary to rule out such a fracture in cases where it may be suspected.

The question of massage and early motion are naturally influenced by such a condition, and the prognosis as to complete motion must be more guarded. As a rule reduction under ether, fixation, and appropriate padding will maintain good position, but it may occasionally be necessary to use a wire nail or to insert a plate; this is a less serious procedure than in the corresponding fractures of the femur, since a small plate might be inserted without necessarily invading the knee-joint. Dr. Lund succeeded in getting an excellent result by the use of a wire nail in a case of fracture of the internal condyle of the tibia with partial dislocation of the lower leg. Repeated attempts to maintain position of the broken tuberosity were unavailing, until the nail was inserted. The result was excellent.

A careful examination of the records of the last three years reveals eighteen cases of very high fracture of the tibia into the knee-joint. The etiology is in the majority of instances a fall striking at the point of fracture, though in one instance it was a crush between logs, and in another it is said to have occurred (together with a high fracture of the fibula)

by a sudden twist resulting from an attempt to board a rapidly moving trolley car, a most unusual example of a torsion fracture. In about one-half the cases, the correct diagnosis was not made even in the hospital until X-ray plates were taken, and these at times revealed fractures of one or other tuberosities without displacement. One case had been considered by an excellent surgeon as a dislocated internal semilunar cartilage. In three of the eighteen cases one or more vertical median fissures existed, constituting fracture of both tuberosities; one case was open, with a triangular bit broken from the front of the tibia.

Marked synovitis is recorded only a few times, and the results at the time of discharge were unexpectedly good, though the arc of motion is not always given. The compound fracture suppurated and was repeatedly operated, leaving a knee with much diminished power of flexion.

Supracondyloid Fracture of Femur.—In the records from 1877 to 1891, twenty-seven cases are noted as "fracture of femur at knee." Of these one had a coincident fracture of the patella, one was a fracture of the external condyle, two of the internal condyle and one a T-fracture. One died on the day after entrance and a second after an amputation of the thigh. The others were discharged either "well," or "relieved." There were no X-rays in this series.

For the three years previous to 1913, there were admitted twenty cases in which fracture of the lower end of the femur invaded the knee-joint. Of these two were open; one of these had other injuries, and the patient was in profound shock, gas bacillus infection developed, followed by pneumonia, and the patient died on the fifth day. The second was in a child of four years, with very extensive lesions of the soft parts; sepsis developed, amputation was recommended and refused for three days; hip-joint amputation was finally done, but death occurred five days later. One case of simple fracture died in five days, but this was also complicated by other injuries.

The term supracondyloid fracture of femur is elastic.

As a rule it is used to mean fracture below the lower third of the shaft. It is often oblique, and a majority of oblique supracondyloid fractures involve the knee-joint, either directly, or through the subcruræus bursa. The deformity is almost invariably of lower fragment backward, and this is maintained by interposition of soft parts, and pull of calf muscles. In the vast majority of cases hyperextension, or the carrying forward of the extended leg, the thigh being fixed, will produce separation of the epiphysis in the young, and supracondyloid fracture in the adult.

In the twenty cases of this series, one only showed a forward displacement in an adult. There was a single case in a boy of eleven years, which gave every clinical symptom of a separated epiphysis; the X-ray, however, showed a fracture of the shaft a scant inch above the epiphysis with an angular (30 degrees) displacement forward from this point. This is the only case found in which history of accident, and clinical signs in a child, pointed directly to epiphyseal separation, and yet a fracture was demonstrated as the actual lesion. There was also one fracture three inches above the condyles in a boy, with lower fragment posterior, this being the only instance of the adult type of supracondyloid fracture in a child.

Treatment.—Five of the twenty cases were treated by open operation; once the lower fragment was pried into place, and remained in fair position; once it was wired, with a fair result; three times Lane's plates were used with moderately good results. The other cases were treated either by direct extension, or extension and the double inclined plane; in one the leg was held at right angles, for the first two weeks, as this seemed to keep the lower fragment from displacement.

The indications for operation have seemed to be, marked and persistent deformity, danger of weak union, and rotation of condyles by backward displacement of upper and of lower fragment, so that flexion of knee may be seriously limited. Men differ widely upon the degree of these elements which makes operation imperative: certain cases of extreme comminution of supracondyloid shaft, which refuse operation,

obtain unexpectedly good results (one such case is at present in the wards); and at times operation does not accomplish what seems fair to expect. On the whole, open operation for supracondyloid fractures will probably be a little more frequent in the future than in the past. But, as in all other localities, non-operative methods should have most thorough and thoughtful consideration before being discarded.

The diagnosis rests ultimately upon the X-ray but may be made clinically more and more accurate by continued thought and care.

CONCLUSIONS.

First, the five principal traumatic bone lesions involving directly or indirectly the knee are influenced less than might be expected by the fact that they invade the largest joint in the body.

Second, trauma affecting the knee-joint, if sufficient to produce fracture, causes fracture of patella most frequently, of femur next in order, and of tibia least often; in patients under 20 years such trauma usually causes separation of the lower femoral epiphysis.

Third, with the exception of sepsis, the other complications added to fractures in this region are: *a.* Greater difficulty in maintaining position of fragments; *b.* greater limitation of motion after union has taken place; *c.* in certain operative cases, an added danger, that of invading a joint with a solid body.

Fourth, the indications for treatment are similar to those applicable to other fractures except that non-absorbable materials should not be used within the limits of the knee-joint unless it is absolutely unavoidable, and the immobilization be practised for a period longer than is advisable in fractures not involving joint cavities.

AN ANALYSIS AND STUDY OF 724 MAJOR AMPUTATIONS.

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IN 1894 the writer published a paper entitled "A Contribution to the Study of Modern Amputations" (*Medical Record*, Nov. 3, 1894). This paper tabulated 340 major amputations performed at the writer's clinic in St. Luke's Hospital.

The present paper adds 384 major amputations, all taken from this clinic, and combines the two lists, thus presenting for study 724 major amputations.

The list published in 1894 is as follows:

Single Major Amputations.	No. of operations.	Deaths.	Mortality percent-ages.
Amputation of arm	27	1	3.70
Amputations of forearm	37	0	0
Amputations at shoulder-joint	13	1	7.69
Amputations of foot, Chopart's	7	0	0
Amputations of foot, Hay's	2	0	0
Amputation of foot, Pirogoff's	1	0	0
Amputations of foot, Syme's	9	0	0
Amputations of leg, lower third	47	1	2.12
Amputations of leg, middle third	28	0	0
Amputations of leg, upper third	22	1	4.50
Amputations of thigh, lower third	44	5	11.36
Amputations of thigh, middle third	25	2	8.00
Amputations of thigh, upper third	8	1	12.50
Amputations at knee-joint	17	1	5.88
Amputations at hip-joint	7	1	14.28
Total	294	14	4.76
Synchronous Double Major Operations.			
Amputation at the shoulder-joint, and the other arm, lower third	1	0	0
Amputation at shoulder-joint and the other arm, middle third	2	0	0

* Read before the American Surgical Association, May 6, 1913.

Synchronous Double Major Operations.	No. of opera- tions.	Deaths.	Mortality percent- ages.
Amputation at shoulder-joint, and the other fore- arm, middle third	1	0	0
Amputation at shoulder-joint, and a leg, lower third	1	0	0
Amputation at shoulder-joint, and operation for compound depressed fracture of the cranium.	1	0	0
Amputation of both arms	1	1	100
Amputation of arm, upper third, and leg, middle third	1	0	0
Amputation of arm, lower third, and forearm, middle third	1	0	0
Amputation of both forearms	1	0	0
Amputation of both feet, Chopart's	2	0	0
Amputation of both feet, Hay's	2	0	0
Amputation of one foot, Chopart's, and other leg, lower third	1	0	0
Amputation of one foot, Syme's, and other leg, lower third	2	0	0
Amputation of both legs	7	3	42.8
Amputation at knee-joint, and other leg, lower third	1	0	0
Amputation at knee-joint, and other leg, middle third	1	0	0
Amputation at knee-joint, and other thigh, lower third	1	1	100
Amputation of one leg, lower third, and exsec- tion of the other ankle-joint	1	0	0
Amputation of one leg, lower third, and other thigh, lower third	2	2	100
Amputation of one leg, upper third, and other thigh, lower third	1	0	0
Amputation of one leg, middle third, and other thigh, lower third	2	1	50
Amputation of both thighs, lower third	2	0	0
Amputation of both thighs, middle third	1	1	100
Amputation of one thigh, middle third, and all the toes of the other foot	1	0	0
Amputation of one thigh, lower third, and opera- tion for removing fragments and apposing and draining compound fracture of the other leg	1	0	0
Total	38	9	23.68
Synchronous Triple Amputations.			
Amputation of thigh, lower third, left arm, lower third, and half of right hand	1	0	0

MAJOR AMPUTATIONS.

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Synchronous Triple Amputations.	No. of opera- tions.	Deaths.	Mortality percent- ages.
Amputation of thigh, lower third, leg, middle third, arm, upper third	2	2	100
Total	3	2	66.6

Synchronous Triple Mixed Operations.

Amputation of thigh, lower third, leg, lower third, and closing and draining extensive lacerations of the scalp	1	0	0
Amputation of thigh, lower third, arm, middle third, and closing and draining extensive laceration of scalp	1	1*	100
Amputation of left thigh, middle third, right foot, (Syme's), removal of fragments, apposition and draining of compound comminuted frac- ture of right humerus	1	0	0
Amputation of both thighs, middle third, and closing and draining extensive laceration of scalp	1	1	100
Total	4	2	50.00

Quadruple Mixed Operation.

Amputation of thigh, lower third, leg, middle third, half of palm of the hand, and closing and draining extensive laceration of scalp and forearm	1	0	0
Total	1	0	0

The added list is as follows:

Single Major Amputations.	No. of opera- tions.	Deaths.	Mortality percent- ages.
Amputation of arm	35	0	0
Amputation of elbow-joint	3	0	0
Amputation of forearm	19	0	0
Amputation of foot, Chopart's.....	8	0	0
Amputations of foot, Hay's	19	0	0
Amputations of foot, Pirogoff's	2	0	0
Amputations of foot, Syme's	11	0	0
Amputation of foot, Lisfranc	1	0	0
Amputations of foot, Mickulicz	2	0	0
Amputations at knee-joint	16	0	0
Amputations of leg, lower third	58	0	0
Amputations of leg, middle third	30	0	0

* Died of cerebritis produced by the injury to head.

Single Major Amputations.	No. of opera- tions.	Deaths.	Mortality percent- ages.
Amputations of leg, upper third	7	0	0
Amputations at shoulder-joint	23	1	4.34
Amputations of thigh, lower third	59	3	5.8
Amputations of thigh, middle third	19	5	26.31
Amputations of thigh, upper third	7	2	28.57
Amputations at hip-joint	3	3	100
Total	322	14	4.34

Synchronous Double Major Amputations.

Amputation of right arm, lower third, and fore- arm, lower third	1	0	0
Amputation of arm, upper third, and leg, middle third	1	0	0
Amputation at shoulder-joint, and lower third of thigh	2	0	0
Amputation of both feet, Hay's.....	1	0	0
Amputation of right leg, lower third, and Syme's amputation of left foot	2	0	0
Amputation of both legs, one lower third, and other middle third	1	0	0
Amputation of right leg, middle third, and Syme's amputation left foot	2	0	0
Amputation of leg, lower third, and arm, upper third	1	0	0
Amputation of leg, middle third and arm, lower third	1	1	100
Amputation of both legs, middle third.....	2	0	0
Amputation of right leg, upper third, and left foot through the metatarsus	1	0	0
Amputation of both legs, one at the knee-joint, the other middle third	1	0	0
Amputations at both knee-joints	2	0	0
Amputation at knee-joint, and leg, lower third...	1	0	0
Amputation of thigh, lower third, and portion of one hand	1	0	0
Amputation of thigh, lower third, and arm, lower third	2	0	0
Amputation of thigh, lower third, and leg, lower third	1	0	0
Amputation of thigh, lower third, and leg, middle third	3	0	0
Amputation of thigh, middle third, and leg, lower third	2	0	0
Amputation of thigh, middle third, and leg, middle third	1	0	0

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Synchronous Double Major Amputations.	No. of opera- tions.	Deaths.	Mortality percent- ges.
Amputation of both thighs, one middle third, and the other lower third	2	0	0
Amputation of both thighs, middle third	3	1	33 $\frac{1}{3}$
Amputation of thigh, upper third, and arm, upper third	1	1	100
Total	36	3	8.33

Synchronous Double Mixed Operations.

Amputation of forearm, middle third, and opera- tion for drainage and suturing laceration of leg	1	0	0
Amputation at shoulder-joint and operation for laceration of a leg and fracture of the femur.	1	0	0
Amputation at shoulder-joint, ligation of the sub- clavian vessels, and exsections of portions of the clavicle and the acromion process of scapula for crush of the upper extremity.....	5	1*	20
Amputation of foot (Hay's), and operation for compound comminuted depressed fracture of the cranium	1	0	0
Amputation of leg, middle third, and operation for compound comminuted fracture of humerus...	1	0	0
Amputation of leg, middle third, and operation for drainage and relief of extensive contusion of the other leg	1	0	0
Amputation of leg, upper third, and operation for closure and drainage of extensive lacerations of hand, and compound fracture of metacarpal bone of the thumb	1	0	0
Amputation at knee-joint, right side, and operation for removing fragments, controlling hemor- rhage and drainage for compound comminuted fracture of left femur	1	1	100
Amputation of thigh, lower third, and operation for extensive laceration of the foot on the other side	1	0	0
Amputation of thigh, lower third, and operation for compound depressed fracture of the skull..	1	0	0
Amputation of thigh, lower third, and operation for removing fragments and drainage of crushed foot	1	0	0
Amputation of leg, lower third, and operation for exploration and drainage of extensive laceration of the perineum	1	0	0

* Hopeless.

Synchronous Double Mixed Operations.	No. of opera- tions.	Deaths.	Mortality percent- ages.
Amputation of thigh, middle third, and operation for drainage and suture of laceration of the other leg	1	0	0
Amputation of thigh, upper third, and wiring com- pound fracture of radius	1	1	100
Total	18	3	16.66

Synchronous Triple Amputations.

Amputation at left shoulder-joint, middle third right thigh, and Chopart's amputation left foot.	1	0	0
Amputation of both thighs, middle third, and arm, upper third	1	0	0
Total	2	0	0

Synchronous Triple Mixed Amputation and Operations.

Amputation of leg, lower third, thigh, lower third, and operation for compound comminuted de- pressed fracture of the cranium	1	0	0
Amputation of both forearms, middle third, and operation for compound fracture of leg and multiple lacerations of scalp	1	0	0
Amputation at knee-joint, left side, amputation of right foot, and operation for reduction of dislocation and fracture of femur	1	0	0
Amputation of thigh, lower third, leg, lower third, and reducing dislocation of hip-joint	1	0	0
Amputation of thigh, lower third, reduction of upward dislocation of hip-joint of other side, and suturing lacerations of leg	1	0	0
Amputation of one leg at knee-joint, plating femur on same side for fracture, and wiring com- pound fracture of the inferior maxilla.....	1	0	0
Total	6	0	0

The combined list is as follows:

Single Major Amputations.	No. of opera- tions.	Deaths.	Mortality percent- ages.
Amputations of arm	62	1	1.61
Amputations of elbow-joint	3	0	0
Amputations of forearm	56	0	0
Amputations at shoulder-joint	36	2	5.55
Amputations of foot, Chopart's	15	0	0
Amputations of foot, Hay's	21	0	0

Single Major Amputations.	No. of operations.	Deaths.	Mortality percentages.
Amputation of foot, Lisfranc	1	0	0
Amputations of foot, Pirogoff's	3	0	0
Amputations of foot, Syme's	20	0	0
Amputations of foot, Mickulicz	2	0	0
Amputations of leg, lower third	105	1	0.95
Amputations of leg, middle third	58	0	0
Amputations of leg, upper third	29	1	3.78
Amputations of thigh, lower third	103	8	7.76
Amputations of thigh, middle third	44	7	15.9
Amputations of thigh, upper third	15	3	20.0
Amputations at knee-joint	33	1	3.03
Amputations at hip-joint	10	4	40.0
Total	616	28	4.54

This gives for study 616 single major amputations, 71 double amputations, 20 mixed operations; that is to say, a major amputation and at the same time another major operation done, but not an amputation.

In these mixed cases sometimes the secondary major operation was of greater magnitude and more exhausting than the amputation itself. There were 16 triple and 1 quadruple amputations.

About fifty of these amputations were done for pathologic conditions, 674 done for crushing injuries received on railroads, mines and factories.

Many of the cases were not received at the hospital until several hours after the injury and had to endure the exhaustion of long journeys as well as the shock of the injury and loss of blood. This fact should be borne in mind in noting the mortality rate.

This paper is intended to be a study based on the experience of a single clinic. All deductions, analyses and conclusions should be understood as representing the convictions of the chief of the clinic. They may be tinctured by personal predilections and may be erroneous. The statistics have been carefully compiled, however, and they as well as the recommendations are honest.

Conditions which Require the Amputation of an Extrem-

ity.—Pathologic conditions will not be considered at all, only conditions resulting from violence will be considered.

Evulsion of a limb, of course, admits of no question.

Annular crushes (that is to say, when all the tissues of a limb have been crushed through the whole of a limited transverse section of the limb), require amputation.

When the soft tissues under the skin as well as the bone have been comminuted by a squeeze or pressure of a car wheel or heavy machinery, even though the skin may not be badly lacerated, an amputation will be required.

If the bone or bones of a limb be comminuted beyond a distance of 6 cm. and the soft tissues immediately about the bone be badly lacerated, one should amputate.

Extensive longitudinal and oblique lacerations admit of conservative treatment as a rule, while circular ones are apt to require amputation.

Circular lacerations involving the chief blood-vessels and nerves as well as the muscles require amputations.

In estimating the condition of an injury the extensive muscular lacerations should receive less consideration than great injury to an extensive area of skin.

Compound fractures which sever a large nerve trunk do not require primary amputation, conservatism should always be tried. The nerve may be sutured and spliced if necessary.

Compound fractures with injury to one system of blood vessels when there are two, do not require primary amputations. When both systems of blood vessels are torn, amputation as a rule is necessary. Anastomoses of blood vessels at the site of a badly mangled limb, may, as a rule, not successfully be done.

When fractures are comminuted as well as compound, injuries to the soft tissues are much more extensive. Areas of thromboses will be much greater and conservatism be less successful.

In any given case while it is probable that conservative attempts may save a limb but leave it in a useless condition, or in a doubtful state, it would be best to amputate if the

amputation would assure a useful stump, unless the injury be high up in the thigh where the mortality rate of amputation is high.

The individual and his trade or employment should always be taken into consideration in determining whether the probabilities should weight for or against an amputation.

Doubtful conservative attempts in cases of very seriously crushed limbs have a larger percentage of mortality than amputations have. This fact should also be taken into consideration.

In all cases of doubt, having carefully considered the foregoing facts, one should always delay the amputation. *Conservation is always the proper policy when there is a good chance for its success.*

The first sign of gas bacillus or streptococcal infection in these very doubtful delayed cases should determine an amputation immediately, and the open treatment of the stump afterward.

The Time for Amputation.—Sometimes it is very difficult to determine whether in a given case an immediate amputation after an injury should be done or not. There can be no doubt, in the writer's opinion, that the proper time for an amputation is as soon after the injury as the patient can safely be prepared for the operation, *if his condition will permit it.* Having, therefore, determined an amputation must be done, the surgeon should carefully examine the general condition of the patient.

A good blood pressure apparatus is an exceedingly useful instrument in making these determinations. Exhaustion from the severity of the injury (Crile's "noci associations" from nerve irritation), exhaustion from psychic shock (this is only temporary), exhaustion from loss of blood, exhaustion from the effects of a long journey to the hospital or to the surgeon, all contra-indicate immediate operations. The degree of exhaustion will be indicated by the blood pressure. In no case operate when the blood pressure is very low.

Psychic shock, by judicious handling of the patient and

the free use of morphine, may soon be relieved and no delay may be necessary. The "noci associations" serve to produce low blood pressure for a longer time. This condition requires relief of nerve irritation by "blocking the nerves," with cocaine, or novocaine, then active heart stimulants. Short delays only are necessary in these cases.

Acute anæmia is the most serious condition of all. This condition requires refilling of the blood tracts as soon as possible. Intravenous infusion of saline solution, hypodermoclysis, proctoclysis, when practicable direct transfusion of blood, besides heart and nerve stimulants should be employed as indicated, and when practicable in the individual cases. Operation must be delayed for many hours as a rule.

The surgeon must thoroughly asepticize the injured member and absolutely control hemorrhage in these cases. He may then wait as long as forty-eight hours if necessary before operating.

As stated before, the first indication of gas bacillus or streptococcal infection makes immediate operation imperative.

In all cases of delayed amputation it is absolutely necessary to control all hemorrhage. It is best to do this when it is fully decided that an amputation should be done, by elastic constriction. When it is practicable the constrictor should be placed over the crushed tissues. When this cannot be done, place the constrictor immediately above the crush and prevent it from slipping by thrusting long sterile pins through the extremity just below the constricting bandage.

A Martin's rubber bandage applied from the fingers or toes upward and *over the crushed tissues to the margin* of uninjured tissues is best in case the limb has not been severed. This makes a safe and less painful constriction.

It is very important never to remove the elastic constrictor applied to control primary hemorrhage until the limb has been amputated. Thus the imprisoned micro-organisms which will inevitably develop in the injured area will not be set free in the circulation even for an instant. Besides it saves much

time, as no attempt will be made to clean and disinfect what usually is a hopelessly soiled and infected area.

Points of Selections for Amputations.—As it was said before, this paper is intended to give the experience of one clinic and the lessons taught by this experience. The writer will not go into any argument with authorities either lay (that is the manufacturers of prothetic apparatus), or professional.

The rule should be to amputate as low down as possible in the upper extremity. An inch of length means a great deal in the usefulness of a stump of the forearm or arm. Even if irregular flaps, and in some cases doubtful flaps must be made to gain length in the stump, it is well to save all one can, and if the skin sloughs repair the loss by grafts later on.

Amputations of the lower extremity require a little discrimination in regard to this rule.

For the foot the writer believes the rule should hold, that is to say, leave as much as practicable. In the case of amputations any where in the foot, it is important to secure ample and good flaps. Fibrous tissue and contracted flaps with thin covering for the ends of the bones almost always produce painful and comparatively useless stumps of feet.

The clinic at St. Luke's Hospital uses mediotarsal amputations (Hay's and modifications of Hay's method) whenever practicable. Chopart's amputation has also given very useful and most satisfactory stumps. It is necessary to have good flaps and flaps which may be brought together without tension, and the anterior tendons should always be cut long enough to form a part of the anterior flaps and be secured by the sutures so they cannot retract. In this way the dreaded equinus produced by the unbalanced contraction of the soleus and gastrocnemius muscles through the tendo achillis may be avoided, and a perfectly movable, well balanced stump be obtained.

Pirogoff's amputation is very rarely used, as osteoplastic attempts are very doubtful expedients in crushed extremities.

Syme's is another amputation which has proven very useful and satisfactory.

Amputations of the leg whenever possible should be done through the lower third; they may be done as high as the junction with the middle and upper third, but very rarely if ever should they be done through the upper third. Upper third of the leg amputations give a mortality greater than at the knee-joint, and the resulting stumps are rarely satisfactory or useful.

Amputations at the knee-joints make very useful stumps. As a rule, the articulating surface should be sawed off so that the intercondylar groove shall be obliterated.

Amputations through the lower third of the thigh give very satisfactory stumps; the mortality is low and usually they heal rapidly. Above the lower third of the thigh the mortality rate increases rapidly. Upper third of the thigh gives very doubtfully useful stumps and the mortality is very high, though one would prefer to amputate there than go to the hip-joint.

Technic and Methods Used in Amputations.—The introduction of iodine as a rapid and efficient sterilizing agent for the skin has been a boon to the surgeon who has to deal frequently with large injuries. Since Grossich proved its value, the technic of preparation for operations and dressing of injured members has undergone a marked simplification in the clinic.

The patient is anæsthetized. Ether is almost always used by the drop method.

The elastic tourniquet is placed over the crushed tissues and carried just beyond the margin of the wound and fastened firmly in place by sterile muslin bandages, or by clamps, or by pins thrust through the tissues below it, and it is not removed until after the ablation of the part. No attempt is made to wash the end of an evulsed limb or the depth of a soiled wound when an amputation is to be done. The end of the limb or the crushed tissues and tourniquet are covered by sterile cloths which are firmly fixed in place, then the skin above the tourniquet is scrubbed with spirits of turpentine, and while the turpentine is still on it is shaved; again scrubbed with turpentine spirits, then scrubbed with alcohol, and thoroughly

dried; then it is painted for a considerable distance over its whole surface with full strength of officinal tincture of iodine. This is allowed to dry, another sterile cloth is placed over the cloths which encompass the wound, and fastened in place. The limb is then elevated vertically, when possible, and another tourniquet adjusted at a point of selection above the region selected for the amputation.

The surgeon and his assistants thoroughly scrub their hands and forearms with soft green soap and running water, using a stiff brush, and disinfect with a 1 : 1000 bichloride of mercury solution and dry them on sterile towels. An amputation gown which covers the whole person including the forearms is put on, a respirator is adjusted over the mouth, a cap is placed over the hair, dry sterile rubber gloves are drawn on and upward over the lower part of the sleeve of the operation gown. Thus prepared, the amputation is done as rapidly as practicable.

As to Flaps.—There is no set rule in regard to them except that they must be wide and long enough fully to cover the stump without tension. It is preferred so to shape the skin flaps that drainage is facilitated by the lines of incision. As much muscle as practicable is included in the stump.

The flaps are formed from without inward and the skin is cut long enough comfortably to enclose the muscles without tension and so shaped that they may easily be adjusted; usually a periosteal cuff is raised and used to cover over the end of the sawed off bone. Osteoplastic operations are very rarely attempted, as it is very doubtful in the severe crushes how far up the injury has extended. Also the osteoplastic operations require more time. The saving of time is usually a very important matter. Besides, the result as regards usefulness of the stumps has been so uniformly good without them that the clinic never adopted osteoplasty in amputations. For the same reasons the cineplastic amputation methods are not used. In pathologic conditions, and in well-to-do patients cineplastic methods may be employed and prove useful.

Nevertheless the profession owes Ceci gratitude for developing the feasibility and usefulness of the cineplastic method.

Bunge's aperiosteal method also has not been employed.

It seems to the writer that osteoplastic and cineplastic methods of amputation offer many advantages in cases where amputations may be done deliberately and when the conditions calling for amputation are not those usually found in extensive comminutions and recent evulsions.

Thrombosis extends always a little distance from the edge of the injury. One never knows in any given case just how far the vessels are thrombosed. These plastic operations would require higher divisions of the bone and soft tissues in order to be quite sure of going through an area clear of thrombi. Besides they require more time to perform, and, as stated before in severe traumatic cases, rapidity of operating is very much to be desired.

Crile's suggestion to avoid "noci associations" by blocking the nerves with local injections of cocain or novocain is most valuable. In amputations this may be done rapidly and efficiently by the injection of the principal nerve trunks as soon as they are reached in the dissection before they are divided. This nerve blocking maintains the blood pressure and thus prevents the extension of shock to a fatal issue. It will be shown later on that the large majority of deaths after amputations for injuries occur within forty-eight hours after the operation from asthenia, due to severe forms of shock. All measures which will prevent or lessen shock should therefore duly be considered and be employed when necessary.

Hemorrhage must be most carefully controlled during the operation, and oozing prevented after the operation by ligating or twisting every bleeding point. The matter of oozing (so called) after amputation is not sufficiently considered by surgeons. Undoubtedly elastic constriction long continued, by paralyzing the local vasomotor control, contributes very considerably to this oozing after amputations. In very large limbs or in regions where the dissection must involve a large area, as in upper thigh and hip-joint amputations it is a ques-

tion whether constrictions ought not to be avoided, and, what the writer has called "the gradual dissection method" be employed. That is to say, the same method one uses in dissecting away a breast and axillary glands for carcinoma, or removing any large tumor from the trunk. This method requires more time, but with the blocking method of Crile it may safely be employed. The freedom from oozing afterward more than counterbalances the extra time required. For shoulder-joint amputations and hip-joint amputations the writer recommends this method. It is well to remember that the first incisions should be so placed that the principal vessels can be reached and be ligated at the very beginning of the operation. The subsequent steps would consist in gradually extending the incisions and ligating or catching with hemostats every vessel as it is reached.

Of the ten hip-joint amputations done by the writer all but three were done after this method.

Results as Regards Usefulness of the Stump.—Of the 724 amputations of all kinds we have records of 18 re-amputations; 1 for conical stump of the upper arm in a young boy; 12 for conical or ulcerated stumps of the legs; and 5 for conical or painful stumps of the thigh. These cases emphasize an important point in regard to amputations near the upper epiphyses in young people. The growth of the shaft of the bones downward in children will nearly always produce a conical stump in a few years, especially in amputations in the upper parts of the arm and thigh. Parents should be warned of this fact. On account of the increased danger of death, however, the knowledge that re-amputation will probably be necessary should not induce the surgeon to make the primary amputation higher up. It is much better to amputate as low down as possible, thus gaining the benefit of the low mortality of the low regions and re-amputate when necessary later on. Conical stumps produced by natural growth of the bones are rarely painful unless irritated by the false limb or some other prosthetic apparatus.

Barring these 18 cases all the patients who survived the

amputations apparently had useful and healthy stumps. There is no note of any case of mediotarsal amputation requiring a second amputation.

Mortality after Amputations.—It must be borne in mind that the statistics given in this paper are really those of amputations for severe injuries. Only 50 cases are credited to pathologic conditions out of 616 single major amputations. Except from hip-joint amputations there is practically no mortality after amputations done for diseased extremities.

Eight (8) cases only are noted as having died of sepsis or of exhaustion later than forty-eight hours after the operation. In other words, practically all deaths after amputations occur within forty-eight hours after the operation. This fact brings home to the surgeon the immense importance of doing everything possible to conserve the strength and resistance of the patient. By far the most important factor in determining the death of a patient when the surgeon is a good aseptician is *acute anæmia*. The writer has discussed this point frequently and has mentioned it very emphatically in the early part of the paper under the head "When to Amputate." It is not necessary to go into the matter further than to say that all the accumulated experience of thirty years' work in very active traumatic surgery goes to confirm the conviction that the saving of blood is the most important feature in traumatic work and that no major amputation ought to be attempted when a good instrument shows a very low blood pressure. Operations in these conditions should be delayed until by the various modern methods the vascular tension shall have been measurably restored.

Examination of the tables shows that single amputations of the upper extremity except at the shoulder-joint may be done practically without any death. Until the upper third of the leg is reached amputation of the lower extremity below the knee has a negligible mortality rate.

Knee-joint amputations give a very low mortality rate. Above the knee-joint the mortality rate rapidly increases. Middle third of the thigh amputations show a mortality twice

that of the lower third, and the upper third amputations are 40 per cent. more fatal than those of the middle third.

Amputations of the hip-joint for crushes of the lower extremity must of necessity be exceedingly dangerous operations. The writer has done seven hip-joint amputations for injuries, two patients died, a mortality rate of 28.57 per cent.

Up to a short time ago the clinic had seven hip-joint amputations with but one death, then came three desperate cases of injury, and two of these died. The record stands at present 10 cases and three deaths, 40 per cent. mortality. This is a very high mortality rate, entirely too high, but it must be remembered that individuals who have such extensive crushes of their lower limbs that a hip-joint amputation is necessary, do not escape other serious injuries. In nearly every case there have been other regions of the body injured more or less severely.

Again, the writer must emphasize the point that of the deaths after single major amputations all but six died within forty-eight hours after the operation and they died from asthenia, chiefly from acute anæmia, which was brought about by hemorrhage before they reached the hospital. Later experience has taught us to defer amputation until the blood pressure has been restored to some extent. The statistics show that by this plan the previous mortality rate has been reduced materially.

Also, the post-operative oozing must sedulously be prevented. Too long continued and too tight elastic constriction provokes oozing by paralyzing the vasomotor constrictors. Always there is more oozing after the use of tight constrictors. Amputations at the hip-joint may be done almost bloodlessly by first ligating the femoral vessels at Poupart's ligament, then by careful dissection and the employment of a large number of hemostats control every vessel as it is reached, the extremity may be removed, and if all vessels be ligated or twisted scarcely any subsequent oozing will occur. We have found this a most efficient method.

Major amputations were at all ages from 10 years to 80

years of age, inclusive, at the clinic. The statistics show the deaths have all occurred, with one exception, in individuals between 15 and 45 years of age. One old man past 70 died. Age seems to affect the mortality very little.

What does markedly affect the mortality is the size of the extremity at the point of amputation. This applies to individuals of lean or plethoric condition. Other things being equal, the man with the small wizened extremity stands a much better chance of rapid recovery after amputations than the one with very large and fat extremities.

This fact accounts chiefly for the large increase in the mortality rate of amputations above the lower third of the thigh. Naturally in a large extremity the dissection is extensive, the wound is large, more blood will be lost and there is greater danger of sepsis.

The multiple injuries and mixed operations especially tax the discrimination of the surgeon both as regards measures for sustaining the strength of the patient and the kind and extent of the operations to be performed. The rules laid down in the foregoing pages apply to these cases, however, equally with the single major amputation cases.

The writer has come to the conclusion that it is not so much the loss of the solid tissues of the extremities but the tremendous "noci associations," and loss of blood which makes double and triple amputations so much more fatal than single ones.

The list of double amputations is large enough to enable one to draw useful conclusions but the triple and quadruple operations are too few to furnish more than suggestions.

At the clinic at St. Luke's Hospital the multiple operations are done synchronously. That is to say, the chief operator and the chief assistant operate at the same time on different extremities, each with a proper corps of assistants. This arrangement permits more rapid work and a shorter period of anæsthesia. Very great care is taken in hemostasis and the preservation of all the blood possible. Also saline infusions are used during and after the operation profusely. Morphia

and cocaine, the one for general effect, the other locally, certainly have most efficient effects in these cases. Asepsis must most sedulously be carried out.

CONCLUSIONS.

A comparative study of the earlier and later lists of amputations shows that the clinic continues to regard the formerly adopted sites of preference the most desirable ones. The mediotarsal amputations have increased in number and have gained in favor against Syme's or the lower third of the leg amputations. Every increment of an extremity possible to save, without serious danger to the flaps and long disability of the patient, should be retained. The exception to this is the upper third of the leg. It is better to amputate at the knee-joint than at this region.

As regards the kind of flaps: for the forearm, anteroposterior flaps with the posterior one-quarter longer are preferred. All amputations of the arm, including those at the elbow, may be done by a circular or modified circular method. The adjustment of the flaps may usually be in an anteroposterior direction. The retraction of the anterior part of the flap at the elbow will convert a circular into an oval shaped flap, the posterior segment will be much longer. This will bring the line of union some distance above the end of the bone.

At the shoulder-joint, also, anteroposterior flaps are preferred. The anterior flap includes the greater part of the deltoid muscle and is longer than the posterior one. The incision in the internal aspect of the extremity should be so placed as to give easy access to the axillary vessels, which should be grasped and controlled as soon as practicable.

Mediotarsal and tarsal amputations are preferred whenever practicable when amputation of the foot is required. It is especially necessary to obtain good, adequate flaps and cut the anterior tendons long enough to be secured by sutures to the posterior flap when forming the stump.

Low down in the leg anteroposterior flaps are preferred

but not the Teale method or any extraordinarily long anterior flap method. In other parts of the leg lateral flaps seem best.

At the knee-joint a long anterior and short posterior flap method is preferred. The patella may be removed or not, according to the conditions of the case.

Lower third of the thigh to the hip-joint anteroposterior flaps with the anterior one longer are usually employed.

We always shape the flaps from without inward, never by transfixion.

The average length of time in the hospital for amputation cases continues to be about 22 days.

The mortality rate for single major amputations has slightly been decreased, viz., from 4.76 per cent. to 4.36 per cent. The mortality rate of double mixed amputations has been reduced from 23.68 per cent. to 11.11 per cent. The combined mortality of the two series is 4.56 per cent. for the single amputations. This is a very low mortality rate for the class of injuries which required these amputations.

The important factors in lowering the mortality of amputations for injuries are:

1. Saving of blood.
2. Careful asepsis or antisepsis.
3. Discriminating when to operate.

The first two will no doubt appeal to every surgeon.

The last one may be resolved practically into the determination of the blood pressure. Operate as soon as the blood pressure will permit. A systolic pressure below 80 should contra-indicate amputation.

SNAPPING HIP (HANCHE A RESSORT; SCHNELLENDE HUFTE).*

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J. L. K., male, twenty-four years, admitted to General Hospital, Nov. 19, 1912. Four years ago his right hip was caught between two railroad cars, causing an anteroposterior crushing. Was treated in another hospital, where he lay in bed 5 months; no splints were used. The hip was useless for almost a year. After recovery he was capable of doing light work.

He now has two complaints: (1) A marked rubbing pain at the crest of right ilium when he carries a heavy weight. This has no relation to the occurrence of his second complaint. (2) When he jumps or carries a heavy weight there is an audible and palpable snapping at the right hip, which he attributes to the head of the femur becoming dislocated and which he can produce voluntarily.

Examination.—When the patient leans slightly to the right side the tip of the eleventh rib touches the iliac crest, causing a painful rubbing on motion. There is now tenderness at this point.

This position of bending toward the right is often assumed in an endeavor to prevent snapping of the hip with its disagreeable sensation and feeling of weakness.

When sustaining most of his weight on the right foot, knee extended, if the patient leans toward his left, a thick band of tissue can be felt passing from the lower and anterior part of the trochanter major upward and backward toward the iliac crest. On extending the hip this band slides off the trochanter backward. If now he twists himself so that the right iliac bone moves forward the thickened band slips forward on the trochanter with a sharp "snap," which is palpable, audible at several feet and the jerking movement of the band is quite visible.

If the band is held backward with the fingers no "snap" oc-

* Read before the American Surgical Association, May 6, 1913.

curs. The motions of the pelvis, which have been described, are equivalent to marked adduction and rotation outward of the thigh. In the recumbent position the phenomenon could not be produced. X-ray examination was negative.

Diagnosis.—"Snapping hip."

Nov. 20, 1912. Ether anæsthesia. Longitudinal incision over great trochanter. Corresponding incision through the *fascia lata*. There was a sausage shaped thickening of the fascia posterior to the wound and to the great trochanter (the fascio-gluteal tract of Heully).

A flap of the periosteum was raised by longitudinal incision from the femur at the lower part of the trochanter major and the posterior lip of the incised fascia lata was sutured to this and to the vastus externus muscle near its origin. The anterior lip of fascia was sutured to the posterior in such a manner as to slightly overlap the original line of suture. The skin wound was closed and the limb fixed in splints.

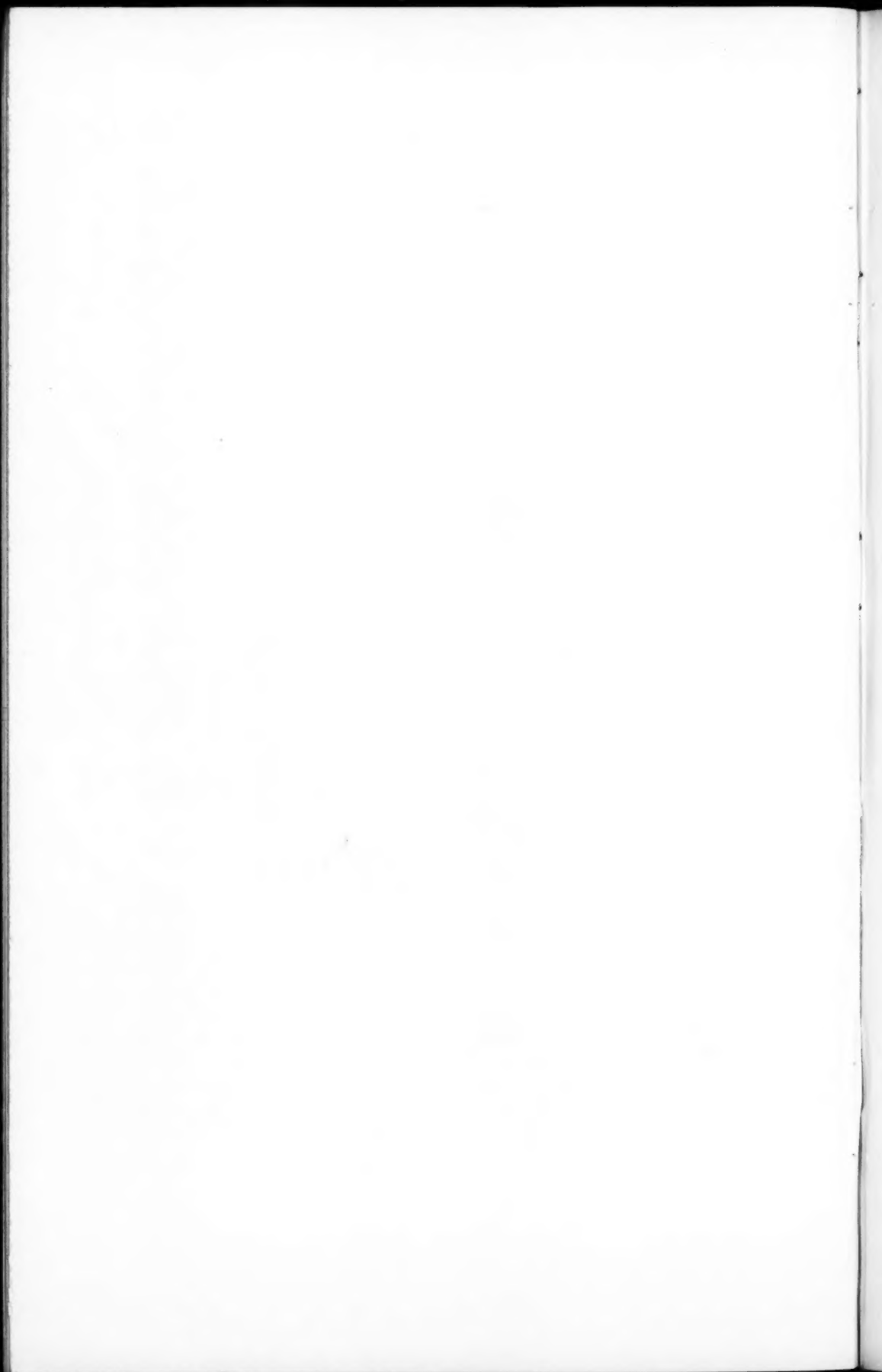
The patient was seen a month after operation when he was able to work. There was no recurrence of the snapping. To the patient the right leg now feels longer than the left, this, of course, being due to his ability to straighten the pelvis. The pain and rubbing at the crest of the pelvis has disappeared, because the patient no longer bends over to the right, bringing his eleventh rib into contact with the iliac crest as he formerly did.

CASE II.—F. D., twenty-three. Male. April 20, 1913. Strongly-built man. About seven or eight years ago patient saw another boy creating interest by apparently voluntarily dislocating his hip and reducing it again with a delectable snap. He admired the accomplishment so much that he successfully imitated it. There is no disability except that the snap is apt to occur involuntarily when he lifts heavy weights. The phenomenon can be produced on both sides. The following is the sequence of events: Bears weight on foot, adducts thigh (or flexes pelvis to opposite side), slightly flexes knee and then a band moves from behind forward over the trochanter with a sudden jerk. By reversing the motions at the hip the band jumps back again to its retro-trochanteric position. The snap both when the band moves forward and backward is visible, palpable and slightly audible. The band is *not* the iliotibial band, but is evidently the anterior margin of the gluteus maxi-

FIG. 1



Showing relation of snapping band to great trochanter.



mus, it follows an oblique line from about an inch anterior to the posterior superior iliac spine downward and forward to the outer surface of the femur five inches below the tip of the great trochanter. This is the location of the band just as it is ready to make its forward snap. The band is about the thickness of a forefinger. (Fig. 1.)

Thomson and Miles in their small but very satisfactory *Manual of Surgery* (Ed. 1912) write of snapping hip that "it is now believed to be due to the tensor fasciæ femoris slipping backwards and forwards over the trochanter."

Perrin in 1859 presented to the Societe de Chirurgie a case which he considered to be one of "voluntary dislocation of the hip." In the discussion which followed it was clearly shown that no dislocation of the bone was present, but that the symptoms were due to action of a muscle or band of fascia gliding and jumping over the great trochanter.

Schoemaker (*Zeitschr. für Orthop. Chir.*, 1901, viii, 444) in a paper entitled "Hysterische Huft-haltung" wrote, "there is no subluxation of the hip, the snapping which is produced by slight movements of the hip ought to be attributed to the tense fascia lata passing over the trochanter."

Bayer (*Archiv für klin. Chir.*, lxxxii, 266) was the first to operate successfully for snapping hip. In his case he made the diagnosis of subgluteal bursitis (hygroma), but on operation found lax connective tissue and *no* bursa between the tendon of the gluteus maximus and the trochanter. He attributed the symptoms to laxity of the tendon and obtained a cure by an operation similar to that which I have described.

Frequently "snapping hip" follows or is the result of trauma, but Staffel reports that he had been telling a colleague about a case of voluntary dislocation of the peroneal tendons (common amongst spirit rappers) when the colleague replied, "That is nothing at all; I can snap with my hip," and proceeded to show that when he extended his hip a tendinous band of fascia sprang backward over the trochanter with palpable, audible, visible snap.

STAFFEL quotes Zur Verth as follows: In my youth I had often to stand for a long time, and to pass the time was accustomed to produce, as I then thought, a dislocation first of one hip and then of the other. Under certain conditions the imaginary dislocation occurred easily and without pain, but with an audible and palpable snap, and snapped back again as easily and painlessly. No ill results followed this practice. . . . When I became a medical student and learned more about dislocations I changed my diagnosis from luxation to subluxation until forced by the publication of recent researches to discard that idea also, and to accept the explanation that the phenomenon was due to the gliding of a band over the trochanter major.

These two cases are apparently not of traumatic origin, and certainly there was no disability resulting. In both, the phenomenon was evidently due to the passing of a band over the trochanter or the band being fixed, to the passing of the trochanter under it.

FERRATON (*Rev. d'Orthopédie*, 1905, p. 45) quoted by Heully and others; operated on a recruit under local anæsthesia. An oblique incision was made upward and backward from the posterior border of the trochanter major in the direction of the fibres and parallel to the anterior border of the gluteus maximus. The anterior fibres of the muscle were penetrated. Exposure of the trochanter showed no lesion. The subgluteal bursa was normal. Voluntary flexion of the thigh provoked a "snap" and at that moment the great trochanter was seen to pass under the muscular mass composed of the anterior fibres of the gluteus maximus. If the muscular mass was hooked up with the finger no snapping could be produced.

VOELCKER (*Beitrage z. klin. Chir.*, lxxii, 619) reported a case of bilateral snapping hip.

Right side. When patient lay on his left side he could produce the snap on the right. Local anæsthesia.

Longitudinal incision behind the trochanter. Division of the fascia behind the palpable, thickened and visibly retracted iliotibial band, exposure of the subjacent fibres of the gluteus maximus which were divided in the line of the incision. Snapping was possible after division of the fascia but not after division of the muscle. A mucous bursa, 6 cm. in diameter, was seen lying on the trochanter and excised.

Left side. Division of fascia as on opposite side. The gluteus maximus was united to the iliotibial band by a strong tendon which received fibres from the gluteus in a penniform manner. As soon as this tendon was divided snapping became impossible.

No suture of fascia to trochanter. No recurrence.

HEULLY reports a case from the service of Prof. Gross. A solidly

built man fell on his right hip—kept on at work but with pain and limping. From time to time there was an abnormal bruit in hip. Six months later he had stooped to pick up a weight when he was straightening himself with the weight, he felt a sharp pain in the hip and was unable to stand up at once. When he did get up he noticed a marked crackling in the hip. Subsequently when he carried weights he had to bear his weight on the left limb.

Examination when the patient was standing showed a muscular prominence apparently due to the tensor fascia lata and accentuated by a depression over the surface of the trochanter major which made the right iliac region appear prominent. The posterior border of the prominence was 6 cm. behind the anterior superior spine.

The same muscular prominence was seen on the left side and played no rôle in the production of the symptoms.

On active flexion of the hip to a right angle the following phenomena occurred: 1. Under the skin covering the lower part of the trochanteric depression there appeared an elliptical prominence about 1 cm. wide and 3 cm. long. It appeared when the flexion reached 15°. 2. When the flexion reached about 45° this prominence suddenly glided forward. 3. At the same instant there was a single dry bruit, like an articular crackle or crepitation.

Palpation of the mobile prominence showed it to be a firm, flattened mass continuous with a band which went obliquely upward toward the iliac crest. The firm mass was 6 cm. below the iliac crest. When the thigh was flexed and rotated inward the band became vertical. . . . The phenomenon only occurred on flexion of the thigh on the pelvis or *vice versa*—it never appeared on rotation or inclination of the pelvis. It was easy to determine the exact position of the mass which caused the snap. The upper border was easily found and was 12 cm. from the anterior superior spine. The subtrochanteric crest was as easily made out; between these was the outer surface of the trochanter. On flexion an elongated mass showed upon the upper part of the thigh on a vertical line passing along the posterior border of the great trochanter. The inferior extremity of this mass was 6 cm. below the tip of the trochanter, the superior extremity reached nearly to the subtrochanteric crest. When flexion attained 45° it suddenly glided forward 3 cm., producing a noise perceptible at a distance. . . . When flexion attained 90° the band prolonging the mobile mass upward was vertical, at 45° it was slightly oblique downward, backward and inward.

Operation showed that the upper part of the femoral insertion of the gluteus maximus tendon was separated for about 1 cm. and formed a prominence, about a finger breadth wide, on the deep surface of the muscle. This was the mobile mass which caused the snapping. The band passing upward toward the iliac crest consisted of the anterior border of the muscle, the fascio-gluteal tract. By passive motion it was possible to reproduce the snapping and to ascertain its true cause, viz., undue mobility of the tendon of the gluteus maximus. Suture of the posterior edge of the wound in the aponeurosis—i.e., the portion of the

fascia united to the muscle, to the periosteum of the trochanter and to the vastus externus led to cure.

NELATON, imagining that the trouble was due to an atypical subluxation, decided to suppress internal rotation so as to prevent the great trochanter from moving too far from the ischium. He dissected a flap as large as the index finger and 25 cm. long from the upper part of the semitendinosus. The pedicle of the flap remained attached to the ischium. He bored a hole through the great trochanter and pulled the free end of the flap through the hole from the digital fossa outward and sutured it to the periosteum on the outer surface of the bone. The flap was long enough to permit of flexion of the hip but prevented rotation inward. Result good.

Out of 41 cases of snapping hip collected from various sources 16 appeared due to trauma, 1 to fatigue and 10 were either congenital or the result of practice. In the rest of the cases the origin was doubtful, some of the patients being military recruits unimbued with professional enthusiasm; others, workmen seeking to take advantage of state insurance and some in which no history was available.

In 17 cases there was a varying degree of disability, in 12 there was no disability, in the rest there was doubt as to disability or no history.

Causes of Snapping Hip.—The following are some of the conditions blamed for the occurrence of snapping hip.

1. Inflamed serous bursæ. It may be remarked that bursitis has been diagnosed before operation, but that during operation no such condition has been found.

2. Malformation of the joint—*e.g.*, enlargement of the articular cavity; increased length of the neck of the femur; increased prominence of the trochanter major.

3. Repeated, involuntary tic like muscular contractions.

4. Simple voluntary contraction.

5. Muscular relaxation. Kusnetzoff and Pupovac think voluntary contraction alone is incapable of producing the snap. True, it is produced during voluntary contraction, but this only puts the real cause in evidence. To Kusnetzoff the real cause is a relaxation of the gluteus maximus due to hemorrhage while Pupovac says, "I admit that the normal fixation of the iliotibial tract is destroyed by a partial tear of the mus-

cular fibres behind the great trochanter." Bayer thinks trauma causes laxity of the gluteus tendon and this permits the fibres of insertion to glide over the trochanter during active and strong rotation while the gluteus is contracted.

Zur Verth believes that a contracted gluteus maximus prevents "hanche a ressort," but that if paralysis weakens the muscle, if a tear separates its transverse fibres from the iliotibial band, if it is elongated by cicatricial tissue, then a sufficient amount of hip flexion determines the snap when the iliotibial band is tense. The necessary tension is obtained by lowering the opposite side of the pelvis (*i.e.*, adduction of the thigh). He writes, "Snapping hip is caused by a trauma acting on the iliotibial band (cristo-femoral tract) or the gluteus maximus and diminishing its contractile power." He also thinks that any one who can voluntarily relax the gluteus maximus is a potential hip snapper.

6. Foreign bodies in or about the gluteal bursa have been considered causes.

7. Heully in a very elaborate article and from experiments on the cadaver came to the conclusion that in traumatic cases the trouble was due to rupture of the upper part of the femoral insertion of the gluteus maximus, the divided tendon remaining as a sort of knob on the under surface of the muscle which still acted of course by means of its aponeurotic insertion. The knob of tendon sliding or bumping back and forth over the trochanter major, according to Heully, occasions the audible, visible and palpable snap.

Heully's explanation does not account for the numerous congenital or non-traumatic forms of the trouble. The writer has twice performed Heully's experiment on the cadaver, but found it impossible to produce any approach to a snap with the knob-like stump of the gluteus tendon, and found that the finger placed between it and the bone while the limb was abducted, was not even pinched to any marked degree when the limb was then adducted, flexed and rotated. If, however, the finger was placed between the lower part of the trochanter and the anterior edge of the gluteus maximus

it was painfully pinched. This seemed more marked after than before the tendon was divided.

Heully noted the same pinching under the anterior edge of the gluteus maximus (fascio-gluteal tract) but does not consider this the cause of the snapping. The iliotibial band has often been described as the band which passes over the trochanter with a snap but it is situated rather too far forward to be really culpable.

The fact that any operation which fixes the anterior margin of the gluteus maximus to the trochanter and to the vastus externus is successful in preventing snapping seems to show that the structure is the culprit. This notion is strengthened by Ferraton's observation that when he hooked up the fascio-gluteal tract with his finger, snapping became impossible. Voelker's division of the upper fibres of the muscle gave a good result, probably because he obtained such a great lengthening of the tract that no tension on it was possible. Possibly rupture or division of the femoral insertion may permit a retraction upward and backward of some of the muscle fibres, enough to cause a sausage shaped swelling of the muscle about its anterior margin and so increase the possibility of the peculiar jumping of this tissue over the trochanter when the proper movements are made.

FIVE CASES OF SUTURE OF THE HEART.*

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THE heart, so far as we are aware, has been sutured 11 times by Philadelphia surgeons, once by Harte, once by Mitchell, once by Bradbury, once by Billings, twice by Gibbon, and five times by ourselves. Six of the patients recovered. Harte, Mitchell, and Gibbon have already reported their cases; Bradbury and Billings intend to publish theirs shortly; and the details of our cases will be found below.

CASE I.—T. E., aged twenty years, colored, cook, was admitted to the Jefferson Hospital, February 29, 1904. He had been stabbed in the chest with a long, rusty penknife. The stab caused severe pain, but neither felled him to the ground nor caused him to feel faint. He walked without assistance to the hospital, a distance of one and a half squares, then began to feel weak, and was found crawling up the steps leading to the entrance of the hospital. After being disrobed a small wound was found just above the third rib, about one inch to the left of the left margin of the sternum. The wound was surrounded by an emphysematous swelling, and bled continuously, the stream of blood being accelerated by each expiration. The temperature was 97 degrees, and the pulse 80, empty and markedly irregular in volume and rhythm. He lay on the right side, breathing 40 times per minute in a short, jerky manner. At times he would complain of a little pain and severe dyspnoea. He was sweating and very pale, and had vomited once. There was neither cough nor blood spitting. The entire left chest was tympanitic on percussion. On auscultation the heart beats could be heard indistinctly; there was no bruit or splashing sound. Under ether anaesthesia operation was begun about 45 minutes after the infliction of the injury. Time of operation about 45 minutes. Amount of ether four ounces. An incision was carried along

* Read before the American Surgical Association, May 7, 1913.

the second rib for four inches to the sternum, then down the left margin of the sternum to the fourth rib, and outward along the fourth rib for four inches.

The musculocutaneous flap was dissected back, and the opening in the chest found between the third and fourth ribs. The exposure was then made more complete by continuing the sternal incision downward for two inches, and the triangular flap thus formed retracted. The third and four ribs were severed and forcibly turned toward the right, fracturing the costal cartilages near the sternum. The knife had passed through the anterior edge of the left lung, the lung had collapsed into the vertebral gutter, and the pleural cavity contained a large quantity of clotted and fluid blood. The opening in the pericardium was easily found by the spurting of blood with each pulsation of the heart; it measured about three-eighths of an inch. The pericardial wound was enlarged in the axis of the heart, and a penetrating wound of the anterior wall of the left ventricle found. This wound was parallel to the axis of the heart, nearer the auricle than the apex, and measured about three-quarters of an inch (larger than either the skin, intercostal, or pericardial wound). Bleeding from this wound was free and continuous, whether more marked during diastole we are unable to state, as the heart was now beating very rapidly and resembled a quivering mass of muscle. The wound was closed with a continuous silk suture (six stitches), the sutures being inserted and tied without reference to diastole for the reason already stated. During the suturing the descending branch of the left coronary artery was punctured near its origin with the needle, causing a profuse hemorrhage, which was controlled by an additional suture. The pericardial and pleural cavities were cleared of blood, and the pleural cavity was irrigated with salt solution. The pericardial wound was sutured with a continuous silk suture, a small opening being left at the lower end for the passage of a gauze drain. No attempt was made to suture the lung, as it was not bleeding. A gauze drain was placed also in the pleural cavity, gaining exit at the lower part of the primary incision. The costal cartilages were sutured with catgut, the skin with silkworm gut. During the operation twenty-four ounces of salt solution containing adrenalin were injected into the circulation, and strychnine and

atrophine were administered subcutaneously. At the end of the operation the temperature was 100.4 degrees; the pulse 150; the respirations 32.

The following day the temperature was 103.4 degrees, the pulse 130, the respirations 56. The patient was delirious and coughed frequently. The fever, the rapid pulse, and the rapid respirations continued for 2 weeks. The cough gradually grew better after the second week; there was never any expectoration. During the first few days there was a copious discharge of blood-stained fluid from the wound. On the fifth day the left chest was dull on percussion, and rough breathing with crepitant rales could be heard over the lower part posteriorly. Examination of the blood at this time showed: erythrocytes, 3,630,000; leukocytes 38,800; hemoglobin, 58 per cent. The chest was explored with an aspirating needle, with a negative result. On the sixth day pus appeared in the wound. Some of the cutaneous sutures were removed on this day and the rest on the eleventh day. On the thirty-fifth day the patient was allowed out of bed. On the fifty-sixth day he was discharged to return to the outpatient department for dressing, a small sinus leading down to the point where the ribs were severed still persisting; this sinus closed a few days later. The pulse varied between 80 and 90. Adventitious sounds were never heard over the heart. The left chest expanded very little on inspiration, and slightly roughened breathing, but no rales, could still be heard.

The facts just narrated were reported to the College of Physicians of Philadelphia, May 4, 1904 (*Am. Jour. Med. Sci.*, Sept., 1904), *i.e.*, a little over two months after the operation. The subsequent history of the case is now published for the first time. Some weeks after leaving the hospital the sinus reopened and finally discharged a long silk thread, probably the one that had been put in the pericardium. The patient worked as a janitor and subsequently as a delivery man for a grocer, an occupation necessitating the handling of heavy baskets and boxes. His health remained good up until the summer of 1908, when he was readmitted to the Jefferson Hospital for tuberculous inguinal adenitis. At this time ether was administered and the caseous glands removed. There were no symptoms referable to the heart or the lungs. Shortly after this operation, however, signs of

pulmonary tuberculosis developed, from which disease he died, Feb. 14, 1909, 5 years after the injury to the heart. The notes of autopsy, which were kindly made by Dr. Krumbhaar, follow:

Anatomical Diagnosis.—Pulmonary tuberculosis (extensive, bilateral, with cavities and small areas of gelatinous pneumonia). Chronic adhesive pericarditis (following stab wound). Localized chronic interstitial myocarditis and antemortem thrombus (left ventricle). Chronic adhesive pleurisy (bilateral). Operative scar on left chest. Anæmic infarct of spleen. Slight red atrophy of liver. Chronic interstitial orchitis.

Heart.—After considerable dissection the heart is separated from the parietal pericardium. It is free only for a small area about the apex. Over most of its surface are somewhat cobwebby, fibrous adhesions, that are broken up without much difficulty. In one spot, however, over the anterior surface of the ventric septum, the size of a silver dollar, the adhesion is very dense, so that it has to be cut with scissors. The heart is but slightly enlarged, weighs 370 grams. It is fairly firm, the color being obscured by the thickened pericardium. On opening, the musculature of the right ventricle is found to measure 4.7 mm. and to be a normal reddish-brown, except under the area of the dense adhesions, where it is much more yellow, though firm. On dissecting away the fibrous tissue over this, it is very hard to tell where the musculature begins. The cavity of the left ventricle is large, the muscle 12–14 mm. thick and of normal color, except under the above mentioned area, where it is much yellower. Toward the apex in the region of the septum it is much thinned and distinct grey lines can be seen running through it. Greyish-red spots, which on dissection show distinct lines of Zahn, are firmly adherent to the septal region. The mitral valves show occasional yellowish dots, the aortic valves are normal. There are occasional slight thickenings of the intima of the aorta. The coronary arteries are free from sclerosis. On dissecting out the branch to the ventricular septum, it is suddenly lost at a point 3 cm. below the auriculoventricular septum and has evidently been obliterated.

Lungs.—Both lungs are enlarged and riddled with tuberculosis. On removing the right lung, which is rather extensively adherent to the parietal pleura, a quantity of purulent fluid escapes. This is found to come from a large cavity occupying practically all of the upper lobe, which is ruptured on removal. The lung is everywhere filled with small and conglomerate caseous tubercles and occasional small cavities are found. The process seems less advanced and more acute in the inferior lobe, where the tissue has a gelatinous, homogenous appearance. The left lung presents a similar appearance to the right except that the cavities are fewer and smaller and no gelatinous areas are found.

Microscopic examination of the heart.—Sections show epicardial fat to be in most places replaced by a fairly dense fibrous tissue, in which small vessels are numerous. The tissue stops raggedly and no epicardium is visible. Throughout all sections there is a marked increase of inter-

stitial tissue, in some areas about blood vessels, in others rather diffuse, while in some, large spaces are found with practically no muscle fibres in them. These contain numerous small vessels. The muscle fibres are in good condition, except those on the edge of or in the isolated fibrous areas. Section through the wall and thrombus shows the same condition of the heart wall, with thrombus closely applied to the endocardium. In no case, however, is the endocardium broken or missing, and no organization of the clot is found. The clot consists of a fibrinous network enclosing many or few leukocytes, alternating with areas in which the red blood cells predominate. Section through the septum immediately inferior to the supposed site of the wound shows the interstitial fibrosis to be even more marked. The muscle fibres in less involved areas are thin and often wavy with loss of cross striæ. The epicardial area shows numerous vessels, including one large one, that are normal, and several nerves cut in cross section. About these and in their capsules are fairly numerous connective tissue cells. No thrombosed vessels are found.

CASE II.—A. J., aged thirty-six years, colored, laborer, was admitted to the Pennsylvania Hospital Feb. 15, 1909. He had been stabbed with a long knife and had started at once for the hospital. After walking about 2 squares he fainted, and was carried into the hospital pulseless and unconscious. He soon revived, however, and when we saw him the pulse was 100, but very weak, the mucous membranes pale, the temperature 97.4° F., the respirations 26. He was conscious and did not complain of pain. The whole left chest, including the cardiac area, was tympanitic, and emphysematous crackling could be felt beneath the skin of the left breast. The heart sounds were weak, but there were no murmurs. Under ether the operation was begun one hour after the injury and lasted 15 minutes. The knife had entered the skin at the middle of the left anterior axillary fold, split the pectoral muscles, and penetrated the second intercostal space midway between the primary wound and the sternum. An incision was made along the second rib from the sternum to the level of the wound in the intercostal space, then downward to the fourth interspace, and inwards to the sternum. The third and fourth ribs were severed at the level of the longitudinal incision, and the flap thus formed turned back over the sternum by fracturing the costal cartilages. The internal mammary artery was not seen. The lung was collapsed and apparently not wounded. The left pleural sac contained a large quantity of blood. An opening large enough to admit the finger was found in the upper anterior part of the pericardium. This was en-

larged in the axis of the heart and a wound about $\frac{1}{2}$ inch long found in the left ventricle near the auriculoventricular juncture and near the interventricular septum, the wound running parallel with the septum. It bled continuously, but the bleeding was more marked during the cardiac diastole. The wound in the heart was approximated with rat-toothed forceps and so held while a continuous silk suture (4 insertions) was inserted. The pericardial sac was not distended but contained considerable fluid blood and a long red rope-like clot. After removing this blood the pericardium was sutured with catgut. The pleural cavity was drained by means of a rubber tube inserted through an incision in the seventh interspace in the posterior axillary line. The severed costal cartilages, the interchondral spaces and the pectoral muscles were sutured with catgut, the skin with silkworm gut. A gauze drain was inserted in the stab wound as far as the chest wall. No stimulants were given before the operation; during the operation strychnine gr. $\frac{1}{30}$ was injected subcutaneously. At the completion of the operation the pulse was 100, the respirations 36, the temperature 97 degrees.

The following day the temperature was 102.6 degrees, the pulse 120, the respirations 60. The temperature remained between 101 degrees and 103 degrees for 10 days, then slowly fell until it reached normal on the 26th day; the pulse and respirations behaved in a similar manner. On the third day the gauze wick was removed from the stab wound and the rubber tube from the pleural cavity, both having ceased to drain. The skin sutures were removed on the eighth day, and several ounces of pus evacuated from beneath the upper and outer angle of the flap. There was no pus in the original stab wound or in the pleural wound; both were closed. All wounds were healed on the 25th day. On the 30th day the patient was permitted to sit up and a day or two later to walk. The temperature having been normal for 16 days, suddenly on the 42nd day ascended to 101 degrees. Examination of the chest by Dr. Newlin revealed a precordial area of dulness, extending from the right edge of the sternum to one cm. beyond the nipple line and from the clavicle down to the stomach. The apex of the heart could be felt in the fifth interspace, midclavicular line. The heart sounds were feeble and rather distant. At the aortic cartilage the second sound was split. Below the left clavicle and in the left axilla the breath

sounds were feeble, distant, and tubular. The lower chest posteriorly was tympanitic; no fluid could be obtained by aspiration. Several days later a skiagram was made, and showed a dense area corresponding to that which had been outlined by percussion. The temperature continued above normal until the 52nd day, when after several unsuccessful attempts to obtain fluid by aspiration the fourth rib between the axillary lines was resected and about one pint of thin yellow pus evacuated from the pleural cavity. Two weeks later (65 days after the original operation) the patient left the hospital with a discharging sinus. At the present time (May, 1913), he is languishing in the penitentiary for burglary. The heart is acting normally and there are no murmurs.

CASE III.—E. M., aged twenty-six years, colored, was admitted to the Pennsylvania Hospital June 17, 1910. He had been stabbed with a pair of scissors. There was a transverse wound in the skin one and a half inches long, in the third intercostal space close to the sternum. The temperature was 95 degrees, pulse 130 and irregular, the respirations 30. The mucous membranes were pale, the patient conscious, and the veins of the face, neck, and arms distended. There was some emphysema below the wound in the skin. The heart sounds could be heard faintly but no murmurs were detected; cardiac dulness extended from the right margin of the sternum to the nipple line. Auscultation and percussion over the rest of the chest were negative; there was no pneumothorax. Before we reached the hospital the resident physician attempted to infuse salt solution into a vein of the arm, but the intravenous pressure was so great that the solution would not run into the vein. Operation was begun two hours after the injury and lasted 35 minutes. On introducing a finger into the external wound it passed downwards and entered the thorax in the fourth interspace close to the sternum. A straight incision was made from the inner angle of the original wound downwards along the margin of the sternum to the fifth costal cartilage. The fourth costal cartilage was then severed at its sternal end and with the underlying triangularis sterni turned outward without injuring the pleura. It was now found that the wound in the pericardium was up beneath the sternum on a level with the third costal cartilage, which therefore was turned outward like the fourth costal cartilage. Subsequently, in order to

obtain more room the fifth costal cartilage was treated in a similar manner, the incision along the margin of the sternum being continued downward to the sixth rib. Thus there was a triangular chondrocutaneous flap containing the fourth and fifth cartilages. The third cartilage was detached from the skin but hinged to the chest by muscular tissue. The pleura, with the lung, was separated bluntly from the pericardium and retracted outward. The pleura was not injured either before or during the operation. The pericardium was tensely distended, liver-colored, and not pulsating. There was no bleeding from the pericardial wound until it was enlarged, when a large amount of fluid and clotted blood escaped, and the pulse immediately fell to 80 and became regular. The cardiac wound was transverse, one-quarter inch long, and in the right auricle. The bleeding from the heart was continuous, the stream spurting about two feet. A finger was placed over the wound and two catgut sutures (No. 3) inserted. Four additional sutures of fine catgut were needed to control the bleeding from the suture holes. The pericardial sac was irrigated with salt solution, the pericardium and the costal cartilages were sutured with catgut, and the skin wound was closed with silkworm gut sutures. Drainage was omitted. At the end of the operation the temperature was 95°, the pulse 116, and the respirations 30.

The following day the temperature was 101 degrees, the pulse 120, the respirations 40. The fever persisted for about one week, when the superficial stitches were removed and a few drams of pus evacuated. The wound healed subsequently without extension of the infection. On the second day the systolic blood pressure was 115, the diastolic 85; hemoglobin 78 per cent. R. B. C. 3,335,000, leukocytes 15,500; polynuclears 82 per cent., lymphocytes 10 per cent., mononuclears 2.5 per cent., transitional 2 per cent., undetermined 3.5 per cent. The patient had a slight cough for about two weeks, but no abnormal physical signs could be detected in the chest. On one occasion the sputum was faintly blood tinged; no tubercle bacilli were found. The patient was kept in bed two weeks and had completely recovered by the end of the third week. He remained in the hospital, however, for two months, performing the services of an orderly. He was last seen in the spring of 1912 (two years after operation) at which

time he was in perfect health; no adventitious sounds could be heard over the heart.

CASE IV.—J. S., aged twenty-three years, colored, laborer, was admitted to the Pennsylvania Hospital July, 1910. He had been stabbed in the chest with a knife during a brawl and was found by the police "lying in a pool of blood." He was unconscious when he reached the hospital, but partly revived before the time of operation. The temperature was 96, the pulse 90 and very weak, the respirations 28. There were drops of sweat on the face, which was very pale. In the fifth interspace directly under the nipple was an almost horizontal wound, one inch long, which entered the thoracic cavity, oozed blood continuously, and was surrounded by an emphysematous swelling. The left chest was tympanitic. The heart sounds were faint but distinct and there were no murmurs. The operation was begun one and a half hours after the injury and lasted 40 minutes. An incision was carried from the inner end of the stab wound inward to the sternum, then upward along the left margin of the sternum to the third intercostal space. The fourth and fifth costal cartilages were severed near the sternum, and the flap turned outward by fracturing the cartilages at the axillary extremities. The left lung was collapsed and the pleural cavity contained a large quantity of blood. The pericardial wound, which was oozing blood, was enlarged, and a transverse wound, about one inch long, found in the left ventricle near the apex. Blood was spurting from this wound, which was temporarily closed with the finger while a continuous catgut suture (seven insertions) was applied. It was necessary also to tie a large branch of the coronary artery which ran to the wound. At this time it was noticed that the cardiac muscle around the wound, over an area of about one inch in diameter, appeared to be abraded. A large amount of clotted blood was removed from behind the heart, the pericardium and the costal cartilages sutured with catgut, the skin with silkworm gut. A rubber tube was inserted into the pleural cavity through a short incision in the seventh interspace, post axillary line. During the operation one pint of salt solution was given intravenously. At the end of the operation the temperature was 94.6, the pulse 100 and very weak, the respirations 30.

The next day the temperature was 103, the pulse 140, the

respirations 60, the leukocytes 4,600, the hemoglobin 76 per cent., the red cells 2,500,000. The pulse and the respirations continued rapid and the patient died 41 hours after operation. The autopsy notes follow:

Anatomical Diagnosis.—Infected stab wound of left ventricle. Acute fibrino-purulent pericarditis. Acute myocarditis. Acute vegetative endocarditis of mitral and aortic valves. Acute fibrino-purulent pleuritis (left side).

The left lung is collapsed and consolidated, the left pleural cavity filled with yellowish fluid, and masses of fibrin resembling custard. This fluid had not drained through the tube because of adhesions which had formed between the lung and the chest wall in front of tube. The pericardium is filled with the same sort of material as the pleural cavity.

Heart.—The heart measures 14 x 9 x 4.5 cm. and weighs 480 grams. On the anterior surface of the left ventricle, beginning about one cm. above the apex and extending upward toward the base just to the left of the septum, is an area, measuring 3 x 1.5 cm., which is slightly depressed below the surrounding muscle and is of a light greenish-grey color. The main descending branch of the left coronary artery runs just to the right of this area. A large branch of this artery, which is given off about 3 cm. above and admits a probe of about 2 mm. diameter, runs to the border of this area and is lost in the greyish, soft tissue. In the middle of the above mentioned grey, depressed area is a wound measuring 3 cm. in length closed by a continuous catgut suture. Sagittal section of the wound shows it to extend into the muscle obliquely, slightly bearing toward the septum. It is about 12 mm. in depth. It does not seem to extend into the left ventricle, there being a ridge of tissue about 2 mm. thick intervening between the bottom of the wound and the endocardium. On the endocardial surface immediately beneath the wound there is a small amount of smooth, elastic, soft, chicken fat clot which is easily pulled away, leaving an apparently smooth endocardium. Section of the heart muscle about the wound shows an area on each side of the wound which is soft and greyish and rather sharply demarcated from the surrounding heart muscle. At the extreme tip of the left ventricle is a yellowish-brown streak in the heart muscle fading gradually into the normal muscle. The muscle at some distance from the wound is uniform, brown, and seems normal. The right auricle, tricuspid valve, right ventricle, and pulmonary auricle appear normal. Along the line of closure of the auricular surface of both flaps of the mitral valve is a line of small vegetations. A slight amount of red elastic fibrin is adherent to these vegetations. They are of about pin-head size and in places conglomerate. Similar acute vegetations are present along the ventricular surface of the leaflets of the aortic valve. The aortic vegetations are similar to those on the mitral valve but not so extensive. The arch of the aorta above the valves is smooth and patchless.

Microscopical examination of Heart.—A series of sagittal sections

was made through the region of the wound in the left ventricle. All sections are similar. They show a heavy fibrinous exudate on the pericardial surface mixed with clumps of cocci. A large coronary artery in the section is occluded by a thrombus. The adventitia is necrotic and pink-staining, and in it are seen deep blue-staining masses of bacteria. On each side of the wound there is a wide band of hyalin, necrotic muscle fibres showing here and there a glial mass of bacteria. Beyond this there is a zone of intense leukocytic infiltration with some fibrin and hemorrhages. There are bacterial emboli in some of the vessels. Beyond this still are seen fairly normal muscle fibres. The deepest portion of the wound is glued together by a thrombus about 1.5 mm. thick, composed of hyalin, fibrin, leukocytes, and red blood cells, i.e., the wound penetrated into the ventricle. A few of the muscle fibres on each side of this are necrotic and there is some infiltration of leukocytes between them.

CASE V.—G. E., aged twenty-one years, colored, laborer, was admitted to the Pennsylvania Hospital Jan. 1, 1911. The police had found him lying in an alley and thought he was dead. His temperature could not be ascertained, as it was below 94, the lowest mark on the thermometer; this low temperature was due in part to the state of the weather, which was very cold. The patient was unconscious, pale, pulseless, and breathing six times to the minute. The left chest was tympanitic anteriorly, dull posteriorly; the heart sounds could not be heard. He was revived somewhat with stimulants, so that at the time of operation the pulse was 108, but scarcely palpable, and the respirations 52. He was still unconscious, but it was necessary to give a little ether because of his tossing about. The stab wound in the skin was in the second left interspace about one inch from the sternum, the wound in the intercostal muscles in the third interspace, the wound in the pericardium beneath the third costal cartilage, and the wound in the heart beneath the second costal cartilage. An incision was made from the original wound to the sternum, then downward to the fourth interspace and outward; the third and fourth costal cartilages were severed near the sternum and the flap turned outward. The left lung was collapsed and the pleural cavity contained a large quantity of blood. The anterior edge of the lung had been perforated but was not bleeding. At one point it was bound to the pericardium by a band as thick as a finger. The pericardial wound was enlarged and a wound found in the right ventricle; this was closed and the heart steadied with rat-toothed forceps while a continuous catgut suture (3 inser-

tions) was applied. A large amount of clot was removed from behind the heart, the pericardium and the costal cartilages sutured with catgut, the skin with silkworm gut. Just after the heart had been sutured the patient stopped breathing and the pulse fell to 52. Artificial respiration for several minutes was followed by spontaneous breathing. During the operation one quart of salt solution was injected intravenously. At the completion of the operation, which lasted about 25 minutes, the pulse was palpable but uncountable, the respirations 60.

The patient died one hour later, the respirations becoming slower and slower, and finally ceasing before the heart stopped beating. At the autopsy the cardiac wound was found to be one-half inch long; it passed into the right ventricle one and one-half inches below the pulmonary valve and just to the right of the interventricular septum, and then through the septum into the left ventricle about 2 inches below the aortic ring. Both ventricles were hypertrophied and the mitral valves were badly diseased.

It is not our intention in this paper to enter exhaustively into the subject of wounds of the heart. When we reported our first case we presented a brief history of the development of cardiorrhaphy and analysed the 60 cases that were on record at that time. Later with Le Conte, we attempted to set down systematically the results of a study of the literature bearing upon the surgery of the pericardium and the heart. (*American Practice of Surgery*, vol. vii.) Here we shall confine ourselves mainly to the ideas that we have formed, concerning the diagnosis and the treatment of cardiac wounds, as the result of our brief experience.

In all of the cases cited above we were sure, or at least as sure as a surgeon should be, that a wound of the heart existed, but we were equally certain of the same diagnosis in several other cases of wound of the thorax in which exploration revealed no wound in the heart. In each of these instances of mistaken diagnosis the thoracic wall was penetrated over the heart, the patient was profoundly shocked, and there existed a hemopneumothorax. In two of these cases, cases of gunshot wound, the pericardium had been grazed and contused but not penetrated. In another case of gunshot wound the

bullet lodged in the pericardium, which contained a few drams of blood, and the heart was contused. In two cases of stab wound the knife had passed down between the pericardium and the lung. In all of these cases the pericardium was incised in order to permit direct inspection of the heart. In two other cases of stab wound of the precordium in which the general phenomena of shock were so pronounced as to suggest the possibility of injury to the heart it was found that the knife had not entered the thoracic cavity. It will thus be seen that a wound in the precordium, even though penetrating, may not involve the heart. Further, the heart may be reached by a knife or a bullet which has passed through the skin of the axilla, back, or abdomen.

Nor can any conclusion as to the participation of the heart in a wound be drawn from the amount of external bleeding. The only really enormous external hemorrhage that we have seen resulting from a wound of the heart caused death within 45 minutes. The patient had been stabbed near the hospital, and we chanced to be in the Receiving Ward when she was admitted. There was a gash several inches long in the left chest, and through this, the hole in the heart could be seen. We immediately closed this hole with the undisinfected forefinger, but life was extinct before sutures could be inserted. In none of the cases of cardiorrhaphy was the blood, at the time of examination, issuing from the cutaneous wound in more than a trickle. This may be accounted for partly by the valvular nature of the tracts leading from the skin to the heart. It is impossible with a single thrust of a narrow bladed knife to create a channel from the skin to the heart which will remain straight. So soon as the patient lies down the thoracic skin glides upward for one or two inches, and the heart likewise ascends. If the pleural cavity is, at the same time, opened, the heart is displaced farther by the resulting pneumothorax. In all of our cases the wound in the heart was above the wound between the ribs, and in three the cutaneous wound was on a level with the interspace next above the one that had been penetrated, thus making the tract V-shaped. In two of these three cases, in one of which the pleural cavity was not opened,

it was noticed that the wound in the heart was considerably higher than the cutaneous wound, hence we conclude that the heart is likely to ascend to a greater extent than the skin. In addition to the influence of this augulation of the tract made by the vulnerating instrument in retarding the outward escape of blood, external hemorrhage is apt to be insignificant, or perhaps even absent, because the blood finds one, and usually two, reservoirs, viz., the pericardial and pleural cavities, into which it may flow unhindered. Consequently a bleeding intercostal or internal mammary artery unassociated with a wound of the pericardium or the pleura may give rise to considerable external hemorrhage because, aside from the cellular tissue, there is no place in which the blood can accumulate, and a wound which involves the pericardium or the pleura may exsanguinate the patient without pouring blood through its external orifice. Apart from its effect in determining the amount of blood which appears on the exterior, this gliding of the tissue, resulting from change in posture, may become a matter of serious importance, from a medicolegal standpoint, to one who attempts to estimate the direction of the original wound.

In four of our cases the local signs of hemopneumothorax were in evidence, and in these cases the area of cardiac dulness was replaced by tympany. In one case, in which the pleura was not injured, the area of cardiac dulness was greatly enlarged. In all cases but one (Case V, in which the heart gave no audible evidence of its activity), the heart sounds were faint but distinct, and in none could any adventitious sound referable to the heart be heard. It may be that some of the bizarre bruits described as indicating a wound of the heart are due in reality to the noise occasioned by the passage of air through the wound in the thoracic wall. In Case I the garrulity of the thoracic wound could have been misinterpreted readily, if on auscultation the opening in the thorax had not been temporarily plugged. Subcutaneous emphysema, which was noted in four of our cases, likewise may interfere with satisfactory auscultation.

The general symptoms of shock and acute anæmia were

pronounced in all of our cases. It is worthy of remark, however, that the pulse, although exceedingly weak and in two instances irregular, was 100 or below in three cases, 108 in another, and only 130 in the case with the highest count. In two instances the patient walked for some distance after the accident. Distention of the veins of the face, neck, and arms, indicating pressure on the auricles as the result of hemopericardium, was present in only one of our cases. This sign, combined with an increase in the area of cardiac dulness, is almost, but not quite, distinctive of a wound of the heart, since it may follow also a wound of the pericardium alone or a wound of the great vessels within the pericardium. External evidences of hemopericardium, however, are not often encountered, because in most instances the blood, even though prevented from flowing out through a valvular opening in the thoracic wall as fast as it flows from the heart, finds an unobstructed outlet into the pleural cavity, and, further, the air in the pleural cavity dislocates and extends over the heart, thus replacing the dulness by tympany. If, as in Case III of the present series, the channel left by the traumatizing agent is strongly augulated and the pleura is not injured the conditions are ideal for the development of the typical signs of hemopericardium and cardiac compression. Doubtless the X-ray would demonstrate an augmentation in the shadow cast by the heart, owing to the accumulation of blood about it, in every case, for the pericardium always contains a large quantity of blood, even when this blood is not under sufficient tension to embarrass noticeably the venous flow to the auricles, but to make a roentgenologic examination in such an emergency would very rarely be for the patient's best interests. Aside from the signs of hemopericardium and cardiac compression, which, when following a penetrating injury capable of reaching the mediastinum, always indicate involvement of the pericardium or the heart, there is nothing to render a diagnosis of a wound of these structures certain except direct palpation or inspection.

In our earlier cases we disinfected the skin with soap and water, alcohol, and bichlorid of mercury, which method consumes too much time if done thoroughly and is unreliable if

done hurriedly. Much more rapid and certain is painting the skin with strong tincture of iodine. After disinfecting the skin we have excised the external orifice of the wound, and then determined whether or not it entered the thorax by digital examination. If the finger passed into the thorax we endeavored to feel, as others have done, the opening in the pericardium, without, however, success, except in the case mentioned above in which death occurred before the heart could be sutured. Failing to discover the pericardial opening in this way we have made a chondro-cutaneous flap of sufficient size to uncover, when turned back, a large area of the pericardium, whereupon the opening in this membrane could be seen and felt without difficulty.

The size and shape of this chondroplastic flap we have varied according to the situation of the external wound and the amount of room necessary to expose and suture the wound in the heart. When the lung was collapsed the flap was made rapidly by cutting through all the tissues, including the costal cartilages, with a sharp, heavy-bladed knife, and then fracturing the cartilages corresponding to the base of the flap by reflecting the flap forcibly, to the left in three cases, to the right in one. So long as there is a pneumothorax it probably makes little difference in which of these directions the flap is turned, and one may be guided by the location of the external wound. If the pleura has not been injured, however, it is of the greatest importance to preserve that membrane intact, and this can be done best by turning the flap to the left, as described in Case III, in which a wide exposure was obtained easily and quickly by pushing back the unopened pleura from the pericardium. Resection of the sternum, we believe, will rarely be indicated, if we dare venture an opinion from the comparative facility with which we were able to suture a wound in the right auricle in this case (Case III) after reflecting the costal cartilages alone. If the external wound were to the right of the sternum and the right pleura were opened one would make the flap in the right instead of in the left chest.

After turning back the flap in the thoracic wall we have enlarged the pericardial opening in the axis of the heart, and

explored the heart by palpation. We have never been able to see the wound in the heart, because of the copious hemorrhage, before it was discovered with the finger. Inspection was useless until the bleeding had been controlled temporarily by digital compression and the blood removed by sponging. Although we have always found the wound in the heart quickly, this is not always possible. Some years ago we watched one of Philadelphia's most skilful surgeons hunt for a number of minutes after the heart had been exposed before the wound was located, and there are several cases on record in which the operator searched vainly for a wound which autopsy revealed to exist.

In all of our cases the blood spurted continuously from the heart, and in Case II it was noted that the spurting was accentuated during diastole. In three instances the finger was kept on or in the cardiac wound until a suture could be inserted. This suture was then used as a tractor while the remaining portion of the wound was closed. In Cases II and V the wound was approximated with rat-toothed forceps during the suturing; this greatly facilitated the operation, and there was no tendency to tearing of the muscle as has been observed by other surgeons, but in Case V the pulsations of the heart fell from 108 to 52 and the patient ceased breathing for a short time, possibly as the result of the greater firmness with which the heart was held by the forceps as compared with a suture tractor. In Case II, however, the cardiac pulsations remained unchanged despite the use of forceps. Here we may call attention to the behavior of the pulse during operation in the other cases. In Case I it became very rapid and continued irregular; in Case III, in which the typical symptoms of cardiac compression were in evidence, it fell, as soon as the pericardium was opened, from 130 to 80 and became regular; in Case IV it increased from 90 to 100.

A continuous suture was employed in all cases, because it can be applied more quickly than interrupted sutures, and because it presents fewer knots on the surface of the heart, and less opportunity for leakage between the points of insertion. The needle was passed deeply without reference to systole or

diastole, and in Case III (wound of the right auricle) must have penetrated the endocardium. Silk was used in the first two cases, and in one of these gave rise to a sinus through which the silk was discharged. In the remaining cases catgut was used. The longest wound in the heart was one inch, and to close this a continuous suture of seven insertions was necessary. In three instances additional sutures were needed to control the bleeding, once because of spurting from the needle punctures (Cases III, wound of the right auricle), once (Case IV) to tie a large branch of the coronary which ran into the wound, and once (Case I) to tie the descending branch of the left coronary close to its origin, where it had been accidentally wounded by the needle. This case of ligation of the left descending coronary artery is of considerable importance in view of the statements of some anatomists and physiologists regarding the fatal effect of suspension of its function. So far as we know this artery has been tied four times in the human being during cardiorrhaphy. Vince's patient died on the second day of pneumonia, Cappelen's on the second day of pyopericardium, Pagenstecher's on the fifth day of empyema and pericarditis. Our patient recovered and was apparently not inconvenienced by the obliteration of his coronary artery. At autopsy, however, five years after the accident, it was found that the wall of the left ventricle was the seat of interstitial myocarditis and in one place near the apex greatly thinned. In all of our cases we found a large quantity of clotted blood in the pericardial sac behind the heart. This clot was scooped out with the fingers and any remaining fluid blood removed with sponges.

In the first case we drained the pericardial cavity with gauze; purulent pericarditis followed. In the other four cases the pericardium was closed without drainage; two of the patients recovered without empyema of the pericardium; one died in one hour; and one died in 41 hours, the pericardium containing large masses of thick custard-like fibrin, which could not have been removed by drainage, and a comparatively small amount of pus. Unless forced to change our present

views we shall not, if we have an opportunity to perform another cardiorrhaphy, drain the pericardial sac. Drainage does not prevent infection, indeed a drain favors infection, especially if the heat strikes against the material employed. Some operators, instead of placing a drain in the pericardial sac, have left the lower part of the pericardial wound open, and inserted a drain down to the opening. This may prevent the irritation and the consequent exudation resulting from the friction between the heart and the drain, but will not prevent the passage of air through the hole in the thoracic wall on its way to and from the pleural cavity when there is a pneumothorax, *i.e.*, in 95 per cent. of the cases. If the pericardium is closed completely and pus later accumulates in the pericardial sac drainage is of course indicated.

In two of our cases a wound of the lung was seen, but, because of the absence of bleeding, was not sutured. Drainage of the pleural cavity was instituted in the four cases in which there was a pneumothorax. In the three in which the patients survived long enough for suppuration to occur empyema developed. At present we should not drain the pleural cavity. We should employ the Auer-Meltzer insufflation apparatus during the operation, remove all the blood from the pleural cavity, and close the thorax completely; or if the insufflation apparatus was not at hand, close the thorax completely and withdraw the air from the pleural cavity by aspiration. The only discernible objection to this course is the possibility that distention of or suction upon the lung might renew or increase the bleeding from a wound in the lung. The importance of an air free pleural cavity, however, cannot be overestimated. The large volume of air existing between a collapsed lung and the thoracic wall contains a great number of bacteria, and unless this air is removed the bacteria settle on the pleura and give rise to infection. In a recent case of exploratory thoracotomy for a stab wound of the lung, the wound in the lung and in the thoracic wall was closed, and as much air as possible aspirated from the pleural sac; recovery followed without empyema.

ANEURISMORRHAPHY

TWO CASES OF ANEURISM TREATED BY MATAS' METHODS *

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It has been well said that Matas' operation for aneurism is the most important method for treating this disease which has been devised since Hunter in 1785 improved on the methods existing previous to his time by giving to the world "Hunter's operation."

In the wonderful progress which has been made in the surgery of the blood-vessels it was inevitable that some better way would be worked out, some way which would diminish the high mortality which characterized the older operations, and Matas struck that way when he operated in 1888 on a brachial aneurism by intrasaccular suture. Since that time, owing to the improvements in asepsis, skill and greater knowledge of the possibilities of vascular surgery, but especially to the work of Matas, the mortality has been reduced, for example, in operations on aneurisms of the subclavian artery, from 73 to 16 per cent. For aneurisms of the extremities we now have reliable and reasonably efficient methods of operation, but for those of the neck and great cavities of the body the means are yet inadequate and unsatisfactory. Whether the future will bring a successful and reliable method of treating aortic aneurisms in the shape of gradual occlusion by Halsted's bands or the resection of the aneurism and the implantation of a section of sound aorta from cold storage or otherwise, or some other yet unknown method, time alone can tell.

I wish to add two cases to the number of those treated by the Matas methods. In Case I it became necessary to change a contemplated reconstructive aneurismorrhaphy into one of

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the obliterative kind combined with an Anel ligation, on account of the impossibility of controlling the blood in the sac.

CASE I.—*Left iliofemoral fusiform aneurism; obliterative method, with ligation of the external iliac artery. Recovery. Death later.* S. McC., white male, aged twenty-nine years, nativity, Nebraska, occupation, laborer and soldier, inmate of the Government Hospital for the Insane, had the following history:

He deserted from the army and was arrested and sent to prison, where he developed dementia præcox and was sent to the Government Hospital for the Insane, August 30, 1906.

The aneurism was first noticed the following November. Previous to its discovery the patient had complained of pain along the inner side of the ankle, the calf of the leg, and over the tumor. There was no history of injury, and he denied having had syphilis but confessed to the free use of alcohol and tobacco. The patient was a medium small, well built and fairly well nourished white man with brown hair, blue eyes and a dull, somewhat depressed facial expression. The apex beat of the heart was displaced slightly to the left of the mammary line. There was a marked systolic murmur heard with greatest intensity at the apex, transmitted toward the axilla and also heard at the angle of the scapula. There was also an aortic, diastolic murmur of nearly the same degree of intensity. Pulse regular, 86 to the minute. A swelling 3 inches long and one and a half inches in width, was noticed in the left groin. There was an expansile pulsation and distinct bruit. Antisyphilitic treatment was tried without benefit, the aneurism was enlarging and it was decided to do Matas' operation on him. Under ether anæsthesia, December 19, 1906, the aneurism and artery above and below were exposed by an incision extending along the femoral artery upward across Poupart's ligament, then outward to the outer side of the inguinal canal, cutting through the muscles and stripping up the peritoneum until the external iliac was exposed as high as the bifurcation of the common iliac. The aneurism was about two inches long, irregularly fusiform in shape and extended above and below Poupart's ligament. The iliofemoral vein was closely adherent to the inner side of the aneurism—too close to dissect free. The artery was clasped

above and below by rubber padded forceps. This stopped pulsation but on opening the sac, red blood flowed out, not in jets, but in a free and steady stream. Attempts were made to control this flow by pressure beneath, and to the inner and outer sides, thinking it might come from a collateral branch, but without effect. So the walls of the sac were sutured together and then turned in by a second row of catgut sutures. The external iliac artery was ligated with kangaroo tendon about one and one-half inches above the sac, and the wound was closed. No pulsation in the arteries of the foot could be felt at the close of the operation. The entire extremity was wrapped in cotton and the foot elevated. The leg and foot kept warm but no pulsation could be felt until fifteen days after the operation (January 3) when it was felt in both tibials at the foot. The patient made an uneventful recovery from the operation but died about 3 months later (April 9) from disease of the heart. Through the courtesy of Dr. Wm. A. White I was able to get a report of the necropsy which is given below. It will be noted that another aneurism was discovered, situated on the superior mesenteric artery.

NECROPSY.—“*External Examination.*—The body is that of a white man, fairly well nourished. The skin is slightly jaundiced. There is a punctiform eruption of the face and neck. There is a large scar in the left iliac region, the result of an operation.

Internal Examination.—Inspection. Skull is broad in front; sutures persistent in frontal region. The skull is rather dense and thicker than the average. Dura is normal. There are pleuritic adhesions on the left side. There is an increase of pericardial fluid. The abdominal fluid is also much increased and is bile stained.

Dissection.—Thoracic Cavity: Lungs are œdematous and russet color. The posterior portion of the right shows some small hemorrhages. Right lung weighed 600 grams, left lung 660 grams.

Heart: Weight, 500 grams. Is much dilated. The tricuspid opening admits four fingers. The pulmonary valves are normal. The anterior wall of the right ventricle shows yellow patches, probably indicating some disease of the muscle. The aortic valves are almost destroyed by a warty endocarditis. Two of the valves are perforated and must have been useless. The

mitral opening admits three fingers and shows very little disease.

Aorta: This vessel is rather small, its walls are thin, there is no arteriosclerosis; the only abnormal appearance seen is a whitish deposit in the intima, probably a fatty infiltration. The lesion is situated in the thoracic and abdominal portions of the vessels. On the superior mesenteric artery at the origin of its principal branches is a small sacculated aneurism about $1\frac{1}{2}$ inches in general diameter. This aneurism is filled with clots, but the circulation has been kept up by the open lumen of the vessel posteriorly, and all the branches are pervious.

The aneurism which has been the seat of operation was examined and at the site of the operation it was extremely difficult to trace the vessel, so obliterated had it been by inflammatory changes. The vessel from the ligature to the origin of the internal iliac artery was filled by a tough partially adherent clot. The demonstration of the collateral circulation was too difficult, and was not done.

Abdominal Cavity.—**Liver:** Weight, 2160 grams. This organ is enlarged and shows a marked nutmeg appearance, with an irregular distribution of the blood. (Acute stage of passive hyperæmia). The gall-bladder contains about 30 c.c. of thick dark ropy bile.

Kidneys: Are cedematous. The cortex is wide and relatively paler than the pyramids. The capsule adheres slightly leaving a few pits over the surface which are not easily explained. Both are in the same condition. Weight of left kidney 190 grams. Weight of right kidney 170 grams.

Spleen: Weight, 410 grams. It is much enlarged. The pulp is soft and full of blood, the result probably of infarctions. The organ is adherent to parts in its vicinity.

Cranial Cavity.—**Brain:** Weight, 1580 grams. Is rather pale. The arteries are not diseased. The right posterior communicating artery is large. The corresponding posterior cerebral is small. The anterior cerebral of the right side and the anterior cerebral of the left are large. Both efficient anterior cerebral arteries come from the same side and are distributed as usual. On the right side the posterior inferior cerebellar is absent, its place taken by the anterior inferior cerebellar.

Conclusion.—The absence of any arteriosclerosis and the presence of localized aneurismal dilatations of the aorta lead to

the conclusion that the condition must have been due to syphilis. The liver was not scarred and there were no other signs of syphilis."

CASE II.—*Popliteal aneurism. Right side. Reconstructive method. Recovery.* February 26, 1910. J. E., male, colored, forty years old, nativity, Virginia, laborer. Admitted to Emergency Hospital.

History.—Patient has had pain in the right knee for about one year but did not know the cause of the trouble. Examination revealed a swelling about the size of a hen's egg in the popliteal space, a little external to the median line, pulsating strongly—

FIG. 1.



Side view: Dotted line indicates suture restoring artery to normal size.

the pulsations being arrested by pressure on the femoral artery at the pelvis.

Under morph. atrop. ether anæsthesia, an incision was made over the swelling, exposing the sac and the artery above. At the lower end of the sac a second aneurism was found, about half the size of the first, oblong and separated from it by a constriction (Fig. 1).

During the dissection the pulsation in the large sac suddenly ceased and on opening it, in addition to the old laminated clot which partially filled the sac, another clot of bright red color was found filling the sac and evidently the cause of the arrested pulsation. It had formed during the process of uncovering the ves-

sels above and below in order that the blood current might be controlled during the operation of suturing the sac. The blood current was controlled by a rubber tube passed around the artery above and clamped with hæmostats, the sac was incised, the clots turned out and the cavity wiped clean. The walls were then turned in by continuous sutures of No. 1 chromic catgut as shown by the dotted line in Fig. 1, thus restoring the original lumen of the vessel.

A second row of sutures was added turning in an additional coat over the first. Blood was allowed to run through by relaxation of the rubber tube and as there was some leaking a third row of sutures was added along both sacs and a fourth row over the larger sac in order to dispose of its coats. Feeble pulsation in the artery below could be felt after the conclusion of the operation. Wound in skin closed with catgut. Patient was put to bed with leg wrapped in cotton and elevated. No pulsation could be felt in the foot.

Next day (27th) feeble pulsation could be felt in the dorsalis pedis artery and the patient was doing well.

February 28: Patient doing well, foot and leg warm but no pulsation could be felt in the foot or leg. No pain, only a slight feeling of numbness in the leg and foot.

March 5: First dressing—primary union. No pulsation in foot, but it is as warm as its fellow and the patient is quite comfortable.

March 13: Permitted to sit up in a chair; condition same.

March 19: Wound healed; condition of circulation same. Discharged, recovered.

When last heard from, about one year later, the patient was apparently well.

ARTERIOVENOUS ANASTOMOSIS FOR THREAT- ENED GANGRENE OF THE FOOT.*

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REVERSAL of the circulation has been attempted in but 50 or 60 published cases of incipient or fully developed gangrene of the extremities, and the results apparently have been so conflicting that the value of the operation is still under discussion. The following case is reported with the idea of adding to the clinical evidence from which final conclusions must largely be drawn.

About two years ago a Russian Jew, aged thirty-nine, developed "Raynaud's disease." The left hand was cold, numb, cyanotic and painful, and finally the tips of several fingers became gangrenous. Without treatment the difficulty gradually disappeared, leaving a few smooth, white scars only.

Six months later severe pain was felt in the calf of the right leg, soon shifting to the vicinity of the large toe; and during the next year or so extensive gangrene of the foot slowly appeared, which finally necessitated amputation of the leg below the knee on July 6, 1912.

Recovery was prompt; but in the course of three or four months, to the consternation of the patient, similar trouble began in the left foot. On December 26, 1912, the foot was cold, numb and cyanotic, and no arterial pulsation could be detected. Gangrene, with ulcerations about the nails, was just beginning at the tips of the first and second toes, shading off toward their bases in a slight bluish discoloration, without even a suggestion of a line of demarcation. There was continuous and exhausting pain.

Through the newspapers the patient had heard of reversal of the circulation in cases like his own, and insisted upon having

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this done before consenting to an amputation. Although faith in the procedure was lacking, it was decided to try it, on the principle that if the chance of success was small the danger of doing harm was equally so.

On December 28, 1912, assisted by Dr. O. M. Shere, a lateral anastomosis was done between the femoral artery and vein, about the middle of the thigh, the vein being exposed peripherally, as far as practicable, and its lateral branches tied. In order to prevent the blood from returning immediately toward the trunk, the vein was proximally ligated, but the artery was not disturbed, thus preserving any remaining circulation which might exist.

For lack of finer material, a number 12 needle with number 16 silk thread were employed. These were soaked in liquid vaseline, which was also smeared liberally over the exposed tissues. After isolating sections of the vessels with rubber-covered clamps and removing the adventitia, oval openings were snipped from their corresponding sides with iridectomy-scissors, the blood washed out with normal salt solution in a medicine-dropper, and the anastomosis completed by a sort of reversed gastro-enterostomy stitch, which turned the edges of the intima outward, leaving a smooth surface internally, one or two extra stitches being required when the clamps were removed. The blood immediately passed in a full stream through the opening, a strong pulsation being seen and felt in both artery and vein as far as they could be followed.

On the next morning, somewhat to our surprise, the skin of the foot, which previously had been cold and cyanotic, was warm and pinkish in color, although the veins of the leg were not distended and no pulsation could be felt anywhere. The pain and numbness had largely disappeared and it was plainly evident that a marked change for the better had occurred. The patient stated that he could feel the warmth and sensation returning a few hours after the operation.

This improvement lasted for several weeks, although it became gradually less manifest as time progressed. A distinct line of demarcation rapidly formed at the base of the large toe and somewhat lower down on the second toe. Altogether it seemed likely that a satisfactory result might be obtained; but to our disappointment the old condition slowly returned, the line of demarcation disappearing and the gangrene progressing on to

the dorsum of the foot, requiring removal of the leg below the knee on February 26, 1913, eight and one-half weeks after the original operation.

Before amputating, an incision was made over the anastomosis in order to observe its condition, it being argued that if blood was still passing into the vein a lower amputation might be done than if the opening was obliterated. On making a slit into the vein blood flowed freely from below, but the anastomosis was evidently closed. A soft dark clot, about the size of a small bean was found adherent to the anastomotic site by its upper extremity. An examination of this, made by Dr. Phillip Hillkowitz, revealed "an inner core consisting of red cells and leucocytes" surrounded by "a broad zone of young fibroblasts imbedded in a structureless stroma," showing that "the clot had been formed several weeks before removal." The character of this thrombus hence pointed to a comparatively recent origin, and indicated that the circulation through the anastomosis perhaps had been efficient for a time at least.

A careful dissection of the amputated leg, made by Dr. Shere, showed marked sclerosis of the arteries and obliteration of their lumina.

The further progress of the case was uneventful.

Between 50 and 60 arteriovenous anastomoses for established or threatened gangrene have been reported, the former operations merely being done in the questionable expectation of saving more of the limb than ordinarily would be possible. The great majority of these cases have terminated unfavorably, in that the circulation of the affected part underwent no immediate improvement, or the improvement was but temporary.

This lack of success has been attributed to a variety of causes—to an improper selection of cases, to defective technic, to immediate or secondary thrombosis, to lack of post-operative care, etc.,—but most surgeons prefer to believe that it is due to inherent deficiencies in the operation itself. Among the apparently successful cases, a number, when considered from an unbiased standpoint, are open to serious question, some being unconvincing and others having

been reported too soon to be of value. Bernheim (*ANN. SURG.*, Feb., 1912) places the apparent successes at 30 per cent.; but in the estimation of many others this is much too high, and the real successes, if any, are probably far below this.

It has been demonstrated with reasonable certainty that a limited quantity of arterial blood may penetrate to the terminal ramifications of the femoral vein after its junction with the artery (2 to 4 per cent. according to Rothmann). It hardly seems justifiable, however, to assume that it will continue to do so, at least in adequate amount, after the numerous lateral anastomotic veins have had time to become dilated, thus carrying the blood back toward the trunk by a much easier and shorter route. Nevertheless, it might be imagined that in certain individuals these veins are unusually few in number or small in calibre, and that under such conditions a reversal of the circulation would be satisfactory in its ultimate as well as in its immediate effects. In order to reduce the number of these lateral veins, it has been suggested that as many as possible be tied at the time of the operation, as was done in the case just reported. This is of course proper enough as far as it goes; but one cannot tie them all, and it is questionable if the obliteration of a few is of sufficient importance to justify the extra time and manipulation required.

It is doubtful if the successful cases reported in connection with the upper extremities (Bernheim, *J. A. M. A.*, Feb., 1913, p. 360; Wieting, *Zent. f. Chir.*, No. 12, 1913, p. 450) are of much value, because spontaneous recovery from beginning gangrene of the fingers is not of uncommon occurrence. In fact, in the case just described, it will be recalled that without treatment of any sort the disappearance of a marked lesion of this kind was so complete that only a few smooth, white scars remained. Similar recoveries have also been seen by the writer and by many others in connection with beginning gangrene of the toes, especially under the favorable influence of rest, posture, improved nutrition, and

stimulation of the circulation, which, it should be remembered, are likewise taken advantage of following arteriovenous anastomosis.

In estimating the worth of the operation it should also be borne in mind that some of the apparently beneficial effects may be due merely to obstruction of the venous circulation. For instance, von Oppel tied the popliteal vein in a case of threatened gangrene of the foot, the procedure being shortly followed by a return of warmth, color and sensation to the affected part, together with the disappearance of the pain which had previously existed—phenomena which, according to Davier, most certainly indicate the success of an arteriovenous anastomosis! In this connection Moskowicz says (*Zent. f. Chir.*, No. 14, 1913, p. 507), "It is more probable that Wieting's anastomosis between the femoral artery and vein owes its effectiveness more to the passive hyperæmia from ligation of the vein than to an actual reversal of the circulation."

From theoretical considerations and from the results so far obtained in arteriovenous anastomosis for threatened gangrene of the extremities, the following conclusions may, perhaps, fairly be drawn:

1. Although the procedure is justifiable in a few well-selected cases, it seldom has been followed by success, and even then its real value may be questioned, owing to the fact that spontaneous recoveries occasionally occur—with as much frequency, possibly, as do operative successes.

2. Owing to the uncertainty of the value of the operation, one should at least endeavor to do as little harm as possible. Hence, from this point of view, it is better to do a side-to-side anastomosis, or to implant the distal end of the vein into the side of the artery, rather than to unite the two vessels end-to-end; thus preserving to the limb its remaining arterial circulation, however little that may be.

3. According to our present knowledge, operations upon the upper extremities should be considered with reservation, owing to the comparative frequency of spontaneous recoveries.

CONTRIBUTION TO THE STUDY OF SARCOMA OF THE FEMUR.

PERIOSTEAL ROUND-CELLED SARCOMA OF THE FEMUR, INVOLVING TWO-THIRDS OF THE SHAFT, WITH VERY EXTENSIVE MULTIPLE METASTASES—APPARENT CURE BY THE MIXED TOXINS OF ERYSIPELAS AND BACILLUS PRODIGIOSUS. WELL 10½ YEARS, WHEN A MALIGNANT TUMOR (SARCOMA AND EPITHELIOMA) DEVELOPED IN THE THIGH AT THE SITE OF AN OLD X-RAY DERMATITIS.*

BY WILLIAM B. COLEY, M.D.,

OF NEW YORK,

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THE patient who is the subject of this paper was shown before the New York Surgical Society on a number of occasions. A full report of the condition up to May, 1912, will be found in the November, 1912, number of the *ANNALS OF SURGERY*, p. 787. The case, at the time of publication, was, as far as I know, entirely unique, being the only one on record of a periosteal round-celled sarcoma of the femur, with metastases, cured by any method of treatment. Of 68 cases of periosteal sarcoma of the femur collected by Butlin, treated either by amputation at the hip-joint or just below the trochanter, only one was permanently cured (well eight years), and in this case there were no metastases. Since the earlier report of my case developments have occurred which render it of still greater interest.

When the patient came under my care in February, 1902, for sarcoma, periosteal, round-celled, involving two-thirds of the shaft (the diagnosis confirmed by microscopical examination by Dr. E. K. Dunham, Professor of Pathology of the Bellevue University Medical School), the involvement of the femur was so great that I advised immediate hip-joint amputation, which was refused by the patient. X-ray treatment was administered for a prolonged period, during which an extensive metastatic tumor occurred in the left pectoral region. A little later, a tumor the size of a child's head developed in the iliolumbar region, involving the ilium. The tumor of the pectoral region was partially removed and X-ray treatments for a short time after the operation were given. No X-ray was applied to the large iliolumbar tumor.

* Read before the American Surgical Association, May 7, 1913.

The toxins were given from February 12 to July 25, 1903, in doses ranging from .5 minim to 20 minims, 86 injections in all being given. The temperature rose to 103.5° F. As stated in the earlier history, the large iliolumbar tumor became almost completely broken down under two months' treatment with the toxins, and drainage was established by an incision made through the upper and posterior part of the ilium, and a large quantity of necrotic tissue evacuated. The patient went on to complete cure and remained well over ten years. Aside from the persistent dermatitis which followed the irritation from the X-ray, in the lower and anterior portion of the thigh, there was also some slight dermatitis in the pectoral region. At the time the patient was shown before the Surgical Society, in April, 1912, a small tumor, the size of an olive, had just developed in the pectoral region at the site of the dermatitis described. This was removed under cocaine the following week and pronounced epithelioma by Dr. Jas. Ewing, Professor of Pathology of Cornell University Medical School, without any connection whatever with the original sarcoma. The patient remained well during the summer, but in the latter part of October, 1912, when I again saw him, I found a very remarkable change had taken place in the old dermatitis in the lower part of the thigh. There was a very large ulcerating area, fully 10 inches in diameter, which showed unmistakable evidence of malignant degeneration, the discharge having the foul odor characteristic of epithelioma. The ulceration rapidly extended in all directions until it covered an area fully 12 x 12 inches and was constantly increasing in thickness. The general health of the patient also became greatly deteriorated. The appearance of the surface of the tumor was extremely characteristic of the tumors which I have seen originate in old X-ray burns. The disease in this case apparently started in the skin and subsequently involved the deeper layers, instead of beginning in the bone and spreading externally. This fact was distinctly shown by the X-ray photograph. The structure of the tumor proved to be very unusual, and different diagnoses were made by several pathologists, although the tumor was regarded by all as highly malignant. I am fortunate in having been able to obtain the following very clear and full report from Dr. W. H. Welch, professor of pathology of John Hopkins University:

Examination of Fragments of Tumor for Dr. W. B. Coley (Nov. 27, 1912).—The specimen consists of several small irregular, rather ragged fragments of solid tissue, the largest being about 2 cm. long, 1.5 cm. broad and 0.6 cm. thick. Upon two of the pieces epidermis can be recognized along one margin.

The microscopical sections show a neoplasm composed of cells and stroma, the former predominating. Some of the sections show only the tumor tissue; others present upon the edge of the tumor an ulcerated surface covered with fibrin, leucocytes and red corpuscles, and two sets of section show cutaneous tissue covered by a thick layer of epidermis. In these last sections the subcutaneous tissues are occupied by the tumor, which has evidently invaded the corium from below and in places appears to have reached the epidermal layer.

The tumor is composed mainly of cells with, as a rule, rather scanty fibrous stroma. The cells vary in size and shape but spherical, oval and polyhedral cells of rather larger size with large vesicular nuclei, containing nucleoli, and with abundant cytoplasm, predominate. There are also fusiform cells, often occurring in bundles, cells with irregular nuclei and with two, three or more nuclei are common. In some fields the cells are closely compacted, while in others there is more of delicately fibrillated or even coarsely fibrous connective tissue between the cells. There is no marked tendency to arrangement of the cells in nests or alveoli.

While considerable parts of the tumor show no evidence of degeneration or marked inflammatory infiltration, there are areas which are extensively invaded with polynuclear leucocytes and lymphocytes, and here the nuclei of the tumor cells often stain diffusely or show other evidences of regressive changes. In parts not thus invaded nuclear figures are numerous.

In the sections presenting a covering with skin, the deeper layers, corresponding to the subcutaneous tissue, show a sarcomatous growth of essentially the characters already described, but in most places extensively invaded with leucocytes.

In the dense fibrous tissue of the corium, in which sections of small hair follicles are numerous, there are scattered strands and islands of richly cellular tissue. The typical large tumor cells can occasionally be seen in these cellular foci, but many of the cells are smaller and appear to lie in and around blood and lymph capillaries, the endothelium of which is swollen and proliferating. The majority of cells in these foci appear to be lymphocytes and plasma cells.

The epidermis is moderately infiltrated with wandering leucocytes. There is some thickening and down growth of the interpapillary processes of epithelium, and over an area of about one millimetre in extent in the sections, where the cellular infiltration of the corium is most extensive beneath the epidermis, there is such an irregular and considerable down growth of the epidermal cells as to suggest an epitheliomatous growth.

Diagnosis.—Large round-celled sarcoma.

There is no objection also to the designation of mixed-celled sarcoma, although the round-celled type predominates. The type is like

that of many periosteal sarcomata, as is indicated by the large cells with irregular and multiple nuclei. The specimen is evidently from metastases invading the skin, if, as I understand from the clinical history, the primary growth was of the periosteum.

While much of the tumor shows the ordinary appearances of sarcoma, it is interesting to note the considerable areas undergoing degeneration and especially the extensive infiltrations with leucocytes.

The interpretation of the lesions of the corium and epidermis over the subcutaneous sarcoma is not so obvious. While occasionally cells resembling the sarcoma cells are seen in the cellular foci of the corium, especially those nearest the subcutaneous growth, many of these foci appear to consist of capillaries with swollen and proliferating endothelium and of accumulations of lymphoid and plasma cells, so that these lesions are probably best interpreted as in the main of a chronic inflammatory character, that is a dermatitis.

The question as to the interpretation of an apparently invasive down growth of epidermal cells, as described above, can hardly be positively answered. Inasmuch as atypical down growths of cutaneous epithelium with inflammations and ulcers of the skin are common and sometimes extensive, it is possible that this is the correct interpretation of the lesion in this case. Still I should not be willing positively to exclude the possibility of a true epitheliomatous growth superimposed upon the sarcoma. The main growth, however, is, as described, a round-celled sarcoma of the type most frequently originating in the periosteum or endosteum (peripheral or central sarcoma of bone).

Pathologist, William H. Welch.

Taken from Dr. Welch's letter dated December 23, 1912:

"I spoke to Dr. Halsted about your specimen. He was extremely interested, and thought that the evidence for efficacy of the treatment by your method was strikingly manifested by the history of the case, and so it seems to me. To have brought about the disappearance of the tumor and to have kept the growth in check for ten years, and then to have the same (presumably) type of growth reappear in the original site and this a markedly malignant type of sarcoma, is a unique chain of events, which is perhaps more convincing than the disappearance of a tumor without a later return. I have not expressed this very clearly I fear, but you will see the point as it impressed Halsted.

(Signed) WILLIAM H. WELCH."

(Professor of Pathology at Johns Hopkins University, Baltimore.)

I also obtained reports on the tissue removed, from Dr. Jas. Ewing, professor of pathology, Cornell University Med. School, and Dr. W. C. Clark, pathologist at the General Memorial Hospital. Their reports are as follows:

"The tissue in the A. G. case shows intact epithelial lining; extensive œdema in many pockets. The derma is the seat of productive

new growth of tissue which, in many places, is composed of cellular and mucoid material. Many spindle- and star-shaped cells—large or huge hyperchromatic nuclei. Such areas grade insensibly into new cellular tissue in which the structure resembles that of large spindle-celled sarcoma. Here the cells are very numerous, large nuclei hyperchromatic, blood-vessels numerous. Parts of these areas are traversed by numerous elongated blood sinuses lined by spindle tumor cells, and the whole process suggests great potentialities of independent growth. To call it sarcoma, seems to me to dismiss it inadequately, but the clinical course may very well be that of spindle-celled sarcoma.

(Signed) J. EWING."

Dr. William C. Clark's report reads as follows:

Tumor of skin of leg, December 21, 1912. Patient, A. G.

Gross examination shows a mass projecting slightly above surrounding skin level. This mass is sharply outlined, measures a cm. in diameter, it is roughened and much firmer in consistency than the surrounding tissues.

On cut section the tumor is found to be sharply outlined, is oval and measures 6 cm. in depth.

Microscopic examination shows that the tumor is a part of the true skin, that is, the epithelial structures of the true skin become a part of the tumor.

The tumor proper consists of large epithelial cells of the squamous variety with relatively large deeply staining nuclei. This is especially true of the cells on the deeper part of the tumor.

The epithelial cells of the central and superficial parts of the tumor are pale, with pale nuclei. At one point in the epithelium there is a small cyst. The periphery of the tumor in contact with the deeper tissues is made up of rounded masses, and columns of epithelial cells, but the general outline of the tumor is sharp, clean cut and is not infiltrating the surrounding tissues. There is an extensive round-celled infiltration. There is no sign of ulceration.

Diagnosis.—Epithelioma of the basal-cell type.

I advised amputation of the leg as soon as the diagnosis was made, but failed to get the patient's consent until January 2, 1913. He was anxious to have the toxins tried again, and they were administered regularly from November 18, to December 5, 1912, in doses ranging from .5 minim to 5 minims, 12 injections in all being given, with no apparent effect upon the progress of the disease. The surface of the tumor was also treated with large doses of very strong radium ointment, principally in the hope of overcoming the very foul odor from the discharges. No effect was noted, however.

He also had one injection of colloidal copper. In view of the patient's failing general health and weak condition, all treatment was abandoned.

Later History.—After the case was reported before the Surgical Society, December 11, 1912, the patient's general condition continually grew worse, and his consent to have the leg sacrificed was finally obtained. On January 2, 1913, I amputated under nitrous oxide gas and oxygen. The entire operation, including the closing of the wound, took 13 minutes. Although the larger nerves were not cocaineized, he showed very little shock from the operation, no nausea or vomiting and made a very good recovery. The limb was taken to the laboratory of Cornell Medical School and Dr. Ewing made a further study of the tumor. His second report reads as follows:

Case of G., April 23, 1913. Tumor of femur. Specimen consists of a leg amputated through the upper third of the thigh. The skin is absent over the anterior and lateral surfaces of the region of the knee-joint for a distance of 20 cm., and in its place is a hard nodular growth, pale in color and spotted here and there with ecchymotic areas varying in size from a pin point to 4 and 5 cm. in diameter, and small ulcerating areas (.5 to 1.5 cm.) containing white cheesy-like material.

On vertical section the tendon and lower portion of the rectus femoris, to within 2 cm. of the patella, is replaced by a tumor mass for a distance of 14 cm. This mass appears quite separate from the periosteum of the femur, a layer of fat being interposed. At its widest point it measures 6 cm. Its upper surface is covered with skin and subcutaneous fat, but the remaining portion has broken through the integument and produces an ulcerating area which is seen on the surface of the limb. The surface of this mass is smooth, white and glistening.

At the point of amputation, the diameter of the femur is not increased and the compact bone appears to be normal; the medullary cavity contains a reddish-brown marrow. In the lower third of the bone, it measures about 7 cm. in diameter and the medullary cavity has entirely disappeared; the compact bone is atrophied, in places being only a shell. Where the normal marrow cavity ends, there is a small deposit of cancellous bone; just below this, there are two bone cysts, measuring .5 and 1.5 cm. in diameter and lined with a glistening membrane. Extending from the cancellous bone, posterior to the cysts, is a mass of ivory-like compact bone which takes in the entire diameter of the femur just below the cysts. Below this compact bone is a sequestrum, 4.5 cm. in length, the remains of what appears to have been a part of the shaft of the

femur; this lies in cancellous tissue. Just above this condyle in the medullary cavity is a well circumscribed tumor measuring 5×3 cm.

The cut surface is white and granular in appearance and cuts with considerable resistance; the edges are well marked and the tumor does not appear to infiltrate the surrounding tissue.

The cancellous tissue in the condyles appears normal. Patella shows osteoporosis. The head of the tibia shows atrophy of compact bone. Medullary cavity is normal, except for an area 5 cm. long by 3 cm. wide, in which the marrow appears to be denser than the surrounding tissue.

Microscopical.—The compact tumor measuring 5×3 cm. in the marrow cavity of the lower end of the femur, is an adult acanthoma (epithelioma). It is composed of compact masses of stratified squamous epithelium of adult type, with spines and pearls and many large, almost cystic areas of hornified material. The stroma is cellular connective.

The tumor in the rectus femoris is composed of many large and small polygonal and spindle tumor cells, with vesicular hyperchromatic nuclei and prominent nucleoli. These cells invade the muscle tissue in rows, small groups, and diffusely. Muscle cells undergo simple atrophy.

The origin and nature of this tumor, I am unable to determine. It appears to be of rapid growth and of recent date. Its structure would ordinarily be designated as sarcoma. I do not think it arises from the femur, since the underlying periosteum is intact and separated from the tumor by a layer of fat tissue. The sequelæ of the original process in the bone are probably to be found in the cysts, the areas of osteosclerosis, and the large sequestrum mentioned in the gross description. It is difficult to determine whether or not these gross lesions can be interpreted as the result of an arrested sarcoma. It would seem possible that they might result from an old osteomyelitis with formation of sequestrum, osteosclerosis and bone cysts.

The epithelioma in the medullary cavity may be interpreted as a metastasis from a lesion in the skin resulting from the X-ray, but no such tumor was recognized in the ulcerated surface of the amputated specimen. It is very probable that the tumor of the quadriceps was an extension from the peculiar process in the ulcerated superficial tissues and that it resulted from the long use of the X-ray.

One to two weeks after the operation the patient developed metastases in the lung and probably also the peritoneum, and died on January 16, 1913.

Blood Analyses.—The various blood counts in this case are of interest:

November 6, 1912: W. B. C. 15,000; hæmoglobin 70 per cent.

December 12, 1912: W. B. C. 20,000; R. B. C. 3,000,000; hæmoglobin 60 per cent.

December 19, 1912: Hæmoglobin 50 per cent.

December 28, 1912: Hæmoglobin 60 per cent.

January 2, 1913: Hæmoglobin 50 per cent.

January 11, 1913: Hæmoglobin 35 per cent.

January 14, 1913: Leucocytes 106,000; polynuclears 99.5 per cent.; mononuclears 0.51 per cent.

January 16, 1913: Hæmoglobin 25 per cent.

On consulting my records, I find an old report of a blood examination, dated May 5, 1902, at which time he was taking X-ray treatment for the periosteal sarcoma of the femur. The report reads as follows: Hæmoglobin 47 per cent.; red cells 3,300,000; white cells 11,100; lymphocytes 11 per cent.; polynuclear 69 per cent., of which 50 per cent. neutrophilic; mononuclear 10 per cent., disintegrating; eosinophiles 2 per cent., multinuclear; myelocytes (small) 8 per cent.

A careful study of the blood changes in bone carcinoma with metastases, has been recently made by Gordon R. Ward (*Lancet*, March 8, 1913, p. 676) based upon four cases. In these cases the hæmoglobin varied between 32 and 115 per cent., the white blood corpuscles in the four cases were 3700, 9000, 1080 and 15,000. The polynuclears varied between 48 and 53 per cent.

The facts in this case have been presented as clearly and judiciously as possible; their interpretation will be left largely to the readers. It is unfortunate that the slide of the original specimen removed from the periosteal tumor of the femur in February, 1902, has not yet been found. In moving the laboratory of the General Memorial Hospital the index of the slides for this particular period was lost. Clinically and macroscopically, the appearance of the tumor was that of a periosteal tumor, involving two-thirds of the shaft of the femur, quite characteristic of sarcoma. A specimen was removed by a large exploratory incision and the diagnosis of small, round-celled sarcoma made by Dr. E. K. Dunham, director of the Carnegie Laboratory, and professor of pathology at Bellevue University Medical School, and by Dr. B. H. Buxton, Assistant Pathologist to the General Memorial Hospital. The subsequent history of the case, I believe, renders the loss of the slide unimportant, except for the purpose of making a comparison of the type of the tumor originally found, and the one that developed ten years later. The extensive multiple metastases which soon developed, confirm beyond question the diagnosis of malignant tumor.

Conclusions.—My own conclusions after a careful study of all the clinical data in this case, together with the elaborate

FIG. 1.



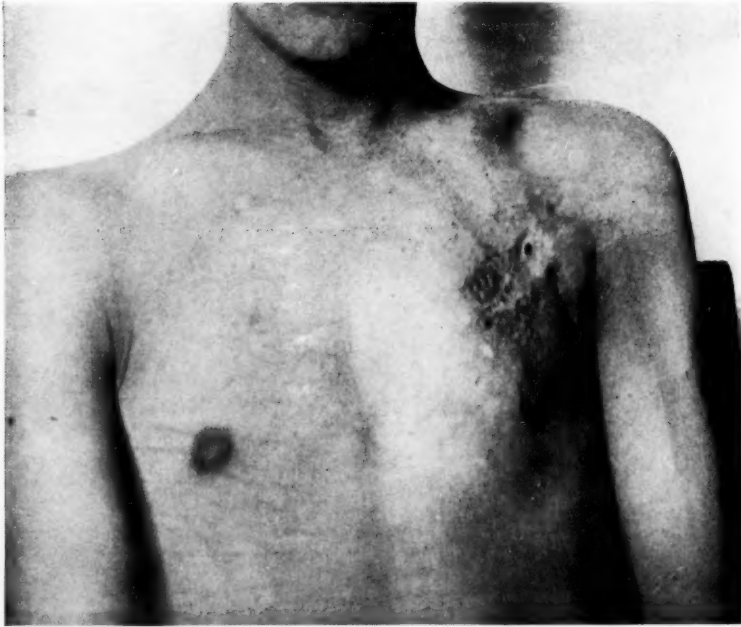
Sarcoma of left femur before treatment. Subperiosteal round-celled. Showing exploratory incision made in February, 1902. Under X-ray treatment developed extensive metastasis in left pectoral region and right ilio-lumbar region. Apparent cure by mixed toxins of erysipelas and bacillus prodigiosus. Patient well ten years later.

FIG. 2.



Sarcoma of femur, after six months' X-ray treatment.

FIG. 3.



Sarcoma of femur. Metastasis in pectoral and lumbar regions. Showing dermatitis after X-ray treatment and site of epithelioma which developed ten years later.

FIG. 4.



Appearance September, 1911.

FIG. 5a.



X-ray taken ten years after beginning of treatment, showing sequestrum and new formation of bone.

FIG. 5b.



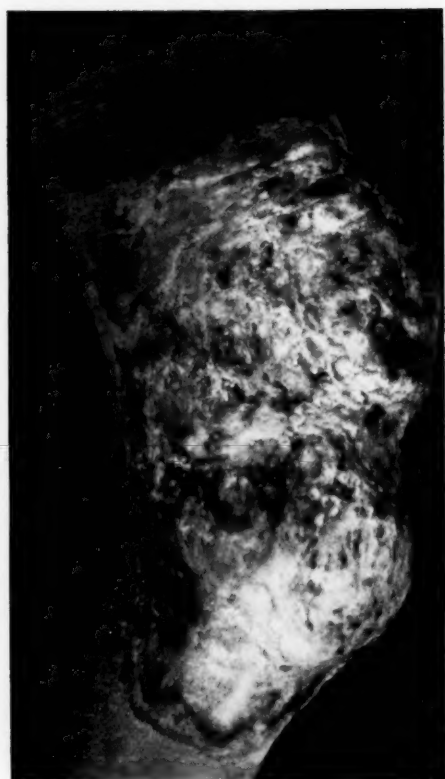
Sound femur.

FIG. 6.



November, 1912. Malignant tumor. Sarcoma and epithelioma at site of X-ray dermatitis, in thigh.

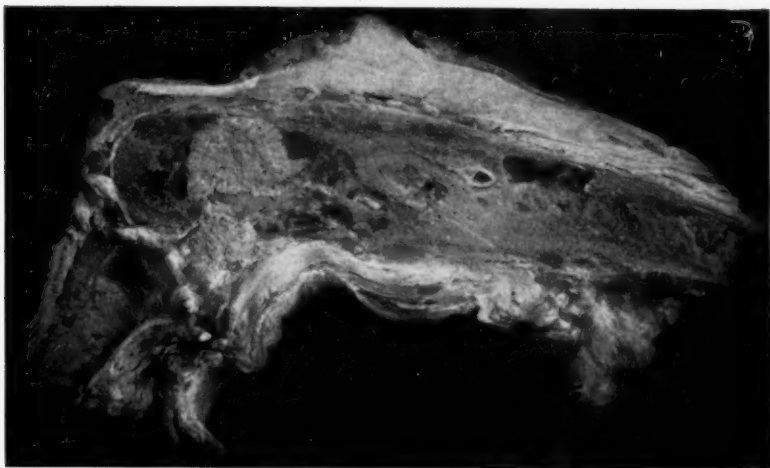
FIG. 7.



January 2, 1913. Showing rapid progress of disease in two months and appearance at time of amputation.

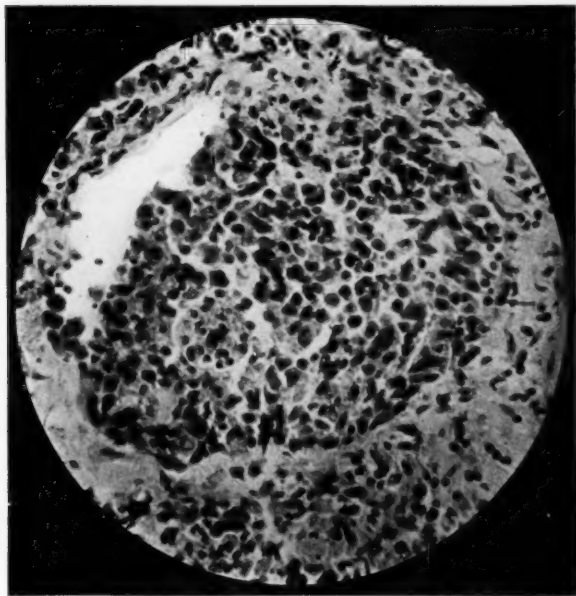
FIG. 8.

a. Intramedullary epithelioma



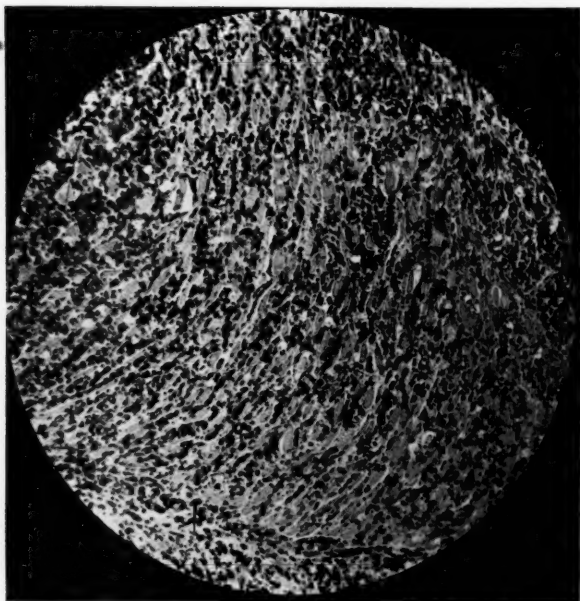
January, 1913. Longitudinal section showing large intramedullary epithelioma. Also bone cyst and sequestrum.

FIG. 9.



November, 1912. External tumor of thigh, involving skin and muscles (sarcoma and epithelioma).

FIG. 10.



November, 1912. External tumor of thigh, involving skin and muscles (sarcoma and epithelioma).

FIG. 11.



January 2, 1913. Intramedullary tumor (epithelioma).

reports of the microscopical findings by such competent men, are, that the malignant tumor which developed in the pectoral region in April, 1912, which was undoubtedly epithelioma, was a simple example of ordinary X-ray cancer occurring at the site of an old dermatitis of ten years before. The later tumor which developed in the thigh, in the autumn of 1912, started in a similar, but much more severe X-ray dermatitis, following X-ray burns of ten years before. This was of a much more highly malignant nature and grew with very great rapidity. The fact that it started in the skin and never—even at the time of death—reached the periosteum, strengthens the opinion that it was a new and independent tumor resulting from X-ray burns, and having no connection with the original periosteal sarcoma of ten and a half years earlier, which had apparently entirely disappeared. The earlier tumor never involved the skin or muscles, and the later tumor never invaded the bone or periosteum, except the metastatic tumor in the medullary cavity which proved to be an epithelioma. Part of the thigh tumor showed, according to Welch and Ewing, structures which must be classed as sarcoma. Other portions of the tumor showed, according to Clark, typical basal-celled carcinoma, while the intramedullary tumor was clearly epithelioma. It would appear then that we were dealing with different types of malignant disease—sarcoma, carcinoma—in the same individual and approximately at the same locality, resulting directly or indirectly from chronic irritation caused by X-rays. Therefore cysts and sequestra are easily explained as the result of a rather extensive chronic osteomyelitis following the breaking down of the sarcoma of the femur under the influence of the X-rays and toxins and infection from the sinus which persisted after the large exploratory incision. I have known of one other case, reported by one of the German clinics, of an X-ray worker, in which two different types of malignant tumor (one a sarcoma and the other carcinoma) occurred in the neighborhood of the wrist, following a dermatitis produced by exposure to the X-rays. The two types of tumor occurred within two inches of each other. (The reference to this case I am unable to find.)

We are all familiar with the experimental production of sarcoma in the rat, by Marie and Clunet, published in the *Second International Congress for Cancer Research*, Paris, 1910. These investigators set out deliberately to produce a malignant tumor by producing a series of X-ray burns in the same locality, pushing the exposure to the point of ulceration, and when this had healed, repeating the experiment 4 to 5 times. At the end of this time, typical sarcoma developed at the site of the exposures.

The exact method by which X-rays produce a malignant tumor is not known. It would be idle to enter into any prolonged attempt to theorize on this question in the present paper.

I believe that X-ray cancer throws little light upon the great problem of the etiology of malignant tumors in general. It adds little to the evidence for or against the extrinsic or microbic origin of the disease. Personally, I believe it can be better explained by the parasitic theory than by any of the cellular or intrinsic theories. We should simply have to assume the existence of a widely disseminated and very generally present microörganism or virus to which nearly every individual is exposed, and yet, which under normal conditions will be successfully withstood by the resisting powers of the tissues. Under certain unusual or abnormal conditions, such as bruising of the tissues resulting from trauma, or the changes caused by chronic irritations of various sorts, including those occasioned by the X-ray, these tissues lose their normal resisting power and furnish a favorable site or nidus for the microörganisms. When once these have obtained a foothold, it will be found very difficult to control or eradicate them.

Some of those who find it difficult to explain the origin of X-ray cancer on the microbic theory, assume that the infectious agent reaches the site of development by reason of abrasions or cracks or external ulceration. If this were true, it would be hard to explain the development of cancer in cases in which there was no ulceration.

My theory is entirely different, in that I believe the infection reaches the particular locality through the blood supply, just as localized tuberculosis of bones or joints in children develops after a trauma, without any external abrasion. In these cases we must assume a latent organism present in the system, remaining harmless until the trauma so lowers the vitality of the tissues as to furnish a favorable nidus for the organism coming through the blood to gain a foothold.

Hesse, of the University Poliklinik of Bonn (*Zwangslose Abhandlungen aus d. Gebiete d. Med. Elektrologie und Roentgenkunde*, Hft. 10, 1911), has made, I believe, the most careful study of the X-ray cancer up to the present time.

Of 90 positively determined malignant tumors following the exposure to X-rays, occurring in 54 patients, 5 or 5.5 per cent. were tumors resembling fibrosarcoma. Only one was a spindle-celled sarcoma as proven by histological examination. Hence, there was but one positive Röntgen sarcoma in the entire series.

Of 94 Röntgen lesions reported, 54 were cases of uncomplicated carcinoma, including one case of sarcoma, the latter in conjunction with "cancroids"; in 13 cases the diagnosis was not absolutely certain or there were other complications; and 27 carcinomas in cases of X-rayed lupus. Twenty-six of the positive cases were observed in America, 13 in Germany, 13 in England and 2 in France.

Hesse brings out the important point that Röntgen carcinoma never develops as a simple or primary injury due to raying, but exclusively in the soil of an already present Röntgen injury.

As regards the etiology of Röntgen carcinoma, he believes that one should certainly consider the possibility of their being due to some kind of infection, either bacterial or protozoic. He states that the skin, which has been exposed to the X-rays, is full of cracks and ulcers, often as thin as tissue paper, and with little or no power of resistance, offers a favorable soil for the entrance of foreign organisms.

Against the infectious theory, he mentions the fact that

in some patients the carcinoma develops in cicatrices that had not shown any sign of inflammation for a long period, in which cases one would have to assume that the cancer germs had remained latent in the tissue and then had become active for some unknown reason. Nevertheless, he states, the infectious theory cannot be excluded.

With reference to therapy, he believes that limited success may be obtained by symptomatic treatment. He adds "The Röntgen carcinoma itself cannot be treated radically enough, and the soil of the carcinoma cannot be treated mildly enough."

Referring to the prognosis, he states that without treatment the carcinoma invariably causes the death of the individual afflicted. Under treatment the cancer as such may be cured but a *restitutio ad integrum* is impossible. A complete cure of the xeroderma pigmentosum does not occur, although attempts to bring the same to a stage where it will cease to further generate carcinoma, may be successful.

**A NOTE ON CANCER OF THE THYROID, AND ITS
EXTENSION TO THE LUNGS BY MEANS OF THE
BLOOD-VESSELS.**

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CASES of cancer of the thyroid are always undesirable to operate on. The writer has operated on many but in very few has the result been entirely satisfactory. The majority of cases have succumbed to local extension at the site of the disease; others have had no local recurrences but have died from extension to the lungs. In only one has a satisfactory result been obtained, this was operated on some ten years ago. After a second operation for recurrence the patient became myxoedematous and has been obliged to take desiccated thyroid ever since but is in good health.

In some cases the extension to the lungs is through the lymphatics, but again the transmission may be directly through the blood-vessels, as in the case reported below. This method of extension is much more common than is supposed and accounts for the rapid dissemination and termination of such cases. In the case under consideration, however, it was some years before the disease extended and for four years she continued her vocation in perfectly good health. When, however, the tumor again showed itself in the neck the growth was rapid and extension to the lungs by means of the blood-vessels quickly followed. This was strange as no glands in the neck or its neighborhood were involved, which accounts, no doubt, for the long interval of comparative health.

This case also teaches us that patients suffering from early cancer should always be operated on, for relief for a time is generally obtained. One case operated on some fifteen years ago had been under observation for a year or more, the patient steadily refusing operation. However, the growth suddenly enlarged greatly (evidently due to hemorrhage), causing great discomfort. Immediate operation showed that the sudden en-

largement was due to hemorrhages into a number of cysts in the gland. Convalescence was uninterrupted, but eighteen months later the patient began to spit blood and consolidation of the left lung was found. He died two months later of exhaustion due to extension of disease to the lungs and frequent hemorrhages. In this case there was no local recurrence and the extension of the disease was through the blood-vessels, the glands not being involved.

Case Report.—Mrs. D., aged thirty-nine, consulted the writer on January 13, 1907, for an enlargement of the thyroid, stating that the neck had been enlarged since childhood and only during the last four years had it grown to its present size. The tumor, which was solid, occupied the whole thyroid, the enlargement was as much on the right as on the left side and quite smooth. She wished to have the growth removed because she was breathless on exertion and had violent attacks of palpitation. Quite recently her voice had changed. She had a pulse of 120 but no other sign of Graves's disease, except great excitability, no exophthalmos, no tremors and no cedema of the extremities. Of late she had lost much weight. Operation, January 17, disclosed a tumor occupying chiefly the left lobe. The whole tumor was removed with great ease and she went home much relieved with the wound soundly healed in two weeks. The pathological report was carcinoma.

In August of the same year (1907) she reported herself quite well and said she could do more work than she had done for years. On January 4, 1911, she reported that the tumor had commenced to grow again on the left side and was of considerable size, though she felt little discomfort. On July 4, 1912, five years after the first operation, she again presented herself, at which time she was in great distress, breathing with difficulty and speaking only in a whisper. She had a tumor the size of an orange in the region of the thyroid, which was quite immovable. She begged for some operative relief so on January 6 an attempt was made to remove the growth. The patient was much emaciated and weak and had not been able to attend to her business for some months.

She took ether badly and there seemed to be obstruction low down, so a laryngeal tube was inserted. This gave no relief and

ether was discontinued and the skin was infiltrated with novocaine. The large mass on the left side was dissected out. The trachea was found flattened and pushed to the opposite side but the larynx itself was free from infiltration. The patient's condition was now so bad that it was decided to do nothing further; the right side was left alone as it was not pressing on the trachea and she was breathing quietly. The wound was closed and the patient removed to the ward. She died some twelve hours later.

The postmortem, which was performed by Dr. Rhea, pathologist to the Montreal General Hospital, showed the following interesting findings:

"The thyroid gland cannot be found as such; corresponding to the site of the right lobe is a large, firm, calcified mass, 6 x 4 cm. with a mass of soft tissue at the lower extremity. The trachea at this point has been displaced to the right and shows flattening on the left side. Occupying the site of the left lobe is a cavity from which a mass of tissue has been apparently removed. The tissues around the trachea are infiltrated with new growth and the phrenic and recurrent laryngeal nerves are bound down and involved by tumor tissue. The left innominate vein is enormously distended and on palpation contains a firm, irregular mass, which on opening is found to be a new growth springing from the posterior wall of the inner surface of the vein and almost occluding it.

"*Lungs.*—In the superficial portions of both lungs several firm, round nodules are felt. Upon section these are found to be small metastatic tumors. They are found mostly in the lower lobes. No thrombi could be demonstrated in the veins or arteries.

"*Microscopical Description.*—The tumor tissue is of the same character wherever found. The tissue consists of cords, groups of cells and acini, separated by a connective tissue stroma. The relative proportion of these elements varies somewhat in sections from different locations. The essential cell of the tumor is epithelial. These cells vary in size and shape, depending on the pressure to which they are subjected. The acini are small and most of them are empty, but some contain colloid material.

"Sections through the wall of the innominate vein and tumor attached to the inner surface show the following: The wall of the vein is thickened and attached to its inner surface is a mass of tissue consisting of tumor cells and stroma; mediastinum and peribronchial tissues show no tumor cells."

HYGROMA CYSTICUM COLLI

ITS STRUCTURE AND ETIOLOGY.

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SCATTERED through the books on surgery and pathology one may find pictures of children with enormous swellings of the neck which are described as hygromas. Although there are a few definite descriptions the statements about these growths are often indefinite, sometimes contradictory, and give evidence of having been copied from one author by another without the opportunity of extensive personal observation. At least three types of growth have been included in some of the descriptions.

1. Cystic tumors which have endothelial linings and serous contents and which grow with much power through the tissues of the neck or downward under the clavicle into the axilla or pectoral region.

2. Lymphangiomas.

3. Branchial cysts.

The term hydroma should be confined to the former class. They are usually described as cysts of lymphatic origin. The loculi are sometimes described as dilated lymph spaces.

The dividing line between them and lymphangiomas may not always be absolutely definite but the typical examples of each are distinct.

Since branchial cysts are now well understood one hardly sees how they need be confounded with hygromas.

The etiology of hygromas is usually referred to as unknown, although several theories for their origin have been given.

* Read before the American Surgical Association, May 8, 1913.

These growths are rare, the total number described in surgical literature is small. Conversation with friends who would have been likely to see them indicates that they are very uncommon.

Rare cases however come in groups, and after having done neck surgery for many years without seeing a single case the writer has within the last year operated on three undoubted cases and a fourth which was probably such a case but in which inflammation had obliterated the finer structure of the cyst wall.

Most of the peculiarities which have been described in the reported cases have been present in one or more of those cases and their histories are here given in detail. The first one, a child of two and three-quarter years, gave the following history.

CASE I.—J. K., age two and three-quarter years. Admitted August 22, 1912. Died Sept. 30, 1912. Nationality, U. S. (Russian). Roosevelt Hospital, History No. B3034.

Chief Complaint.—Swelling of right neck and shoulder.

Present Illness.—When patient was three months old the mother first noticed a small swelling, the size of the tip of the little finger, just above the middle of the clavicle on the right side of the neck. The skin over it was normal, it was not painful or tender and could be made to disappear by firm pressure downward. The lump has been gradually growing larger in spite of firm bandages, which used to make it disappear but no longer do so. Following whooping-cough last winter it grew rapidly larger. Four days before admission patient had a fall, striking the lump, since which time it has been somewhat reddened and slightly tender. Otherwise a healthy normal child. Bowels regular, appetite rather poor.

Past History.—Has had whooping-cough, pneumonia twice, had "yellow jaundice" one year ago. Is rather subject to coughs. Had a similar lump egg-sized in right axilla, with some symptoms of reducibility, removed at a dispensary last year.

Family History.—No history of tumors or fistulæ about the neck. No "lung trouble" in family.

Physical Examination.—Patient is a well-nourished, healthy looking girl baby, appears restless but not ill.

Local Condition: On the right side of the neck is a globular swelling about 4 inches in diameter extending from the acromion to the anterior border of the sternomastoid and from the spine of the scapula to well in front of the clavicle. The skin over it is smooth but somewhat ecchymotic as from a contusion. On palpation it is soft, fluctuating and can be somewhat reduced in size by firm pressure. It is apparently not tender. On forced expiration there is an expansile impulse, percussion flat.

Eyes, Ears, Nose, and Throat: Negative.

Skin: Reddish maculopapular eruptions on chest and back.

Chest: There is marked inspiratory retraction of lower ribs in front on both sides, sternum very prominent.

Lungs: Clear.

Heart: Not enlarged. Sounds of good quality. There is a rough systolic murmur heard over the left half of base, transmitted upward toward both clavicles.

Abdomen: Rather a pot-belly with an umbilical hernia. Liver and spleen not felt.

Extremities and Genitals: Apparently normal.

Operation (August 23, 1912).—A transverse incision was made above the clavicle and parallel to it. The cyst was enucleated through this incision as far as the pedicle which came just in front of insertion of sternocleidomastoid muscle at the inner edge of sternum. When the cyst was opened it was found that it ran in under the sternum into the thoracic cavity but extrapleurally. It was shaped like an hour-glass and the constricted portion was large enough to admit the finger, the inner dilated portion seemed to have a content of 3-4 oz. and went up as far as thyroid and downward under the sternum for about 2 inches, outward under the clavicle for an inch or more. As much of this lining membrane as could be dissected away was drawn out into the wound and cut off. No attempt was made to lay open this entire inner dilated portion, the condition of child would not warrant so extensive a procedure. Wound closed without drainage. Time of operation 45 minutes.

The recovery from the operation itself was prompt and satisfactory, but the swelling quickly recurred and on September 17, a second operation was done.

Second Operation (September 17, 1912).—Anæsthetic, ether. A transverse incision was made from inner end of clavicle well back to posterior portion of neck. The skin and superficial fascia were dissected up and the cyst found to have reformed in the position where it previously existed. The prolongation which extended down under the sternum could not be found. The cyst was 3 x 4 inches long and 2 inches wide. It presented the same characteristics as the one previously removed. It was dissected out in its anterior and lower and upper portions and was found to have a pedicle which extended inward and backward and posterior to one of the scaleni muscles. After careful dissection this pedicle was divided but it frayed out and there was no evidence of an opening which extended further. The cyst contained clear serous fluid; there was considerable fatty tissue on its outer side, also some lymphatic tissue. The wall was thin and similar to one previously removed. There was no evidence of epithelium or communication with the deeper structures.

The child showed considerable reaction after the second operation. There was free serous discharge, on the seventh day there was hemorrhage from the wound, some oozing on the following day and on the tenth day she died.

Pathologist's Report (R. H. Pat. No. B-506).—J. K., August 23, 1912, Specimen: Cyst wall.

Gross Examination: Specimen consists of a thin-walled smooth cyst, with an opening about 2 cm. in diameter at one end. Some areas are red in color, others thin and upon holding to light are translucent. A small thin-walled cyst containing a few drops of serous fluid was found within the cyst wall.

Microscopic Examination: Section shows a thick-walled cyst which is involved in a chronic inflammatory reaction. There is an increase in fibrous connective tissue especially around the blood-vessels which are numerous. Areolar tissue is present in the outer portions in which there are scattered aggregations of lymphoid follicles. No definite type of cell can be made out lining the cyst though in some places they have the appearance of much flattened endothelial cells. This inner part of the wall shows a marked infiltration of round cells.

Diagnosis: Chronic inflammation of cyst wall.

Pathologist, Baldwin Mann, M.D.

Pathologist's Report, second specimen. (R. H. No. B-786).—J. K., age two and three quarter years, Sept. 17, 1912.

Specimen: Cyst.

Gross Examination: Specimen consists of a mass of fibrous and fatty tissue containing a few lymph nodes, and a small smooth lining of a cyst.

Microscopic Examination: Section is composed of muscle and connective tissue, containing numerous rather congested blood-vessels, considerable fat and a few nerves. Round cell infiltration is present throughout. There is a definite cyst lined by a single or double layer of rather large cells with elongated nuclei. Lymph node shows moderate hyperplasia.

Diagnosis: Cyst wall showing chronic inflammation. Moderate hyperplasia of lymph node.

Pathologist, Mortimer Warren, M.D.

CASE II.—J. A., age twenty months. St. Mary's Free Hospital for Children. History No. S. 10979. January 18, 1913. Sent by Dr. John McBarron. Ever since birth the mother had noticed what she called a "bubble" just beneath the left clavicle. This apparently diminished on pressure and the mother had not noticed any apparent change in it until two weeks or so ago. Then decided enlargement appeared over the upper left side of the chest in front. The child was sent to the hospital and found to have a very prominent cystic tumor in this locality. Just beneath the clavicle the cyst seemed thin walled, further down it had apparently thicker walls. It extended from the sternum to the outer edge of the pectoralis major and from the sixth rib to the clavicle.

The child's parents were first cousins and the entire family of six children had been defective in some way. This one seems idiotic. It was impossible to keep him quiet long enough to get a good picture of him and finally the picture had to be taken while he was under an anæsthetic.

Operation (January 21).—A curved incision with its convexity outward was made from above the clavicle to the sixth rib and axillary line. The pectoralis major was found to be in front of the cyst. Its fibres were therefore split with the hope of extracting the cyst through this split; this however was not possible. It was found that a portion of the cyst projected between the upper fibres of the pectoralis major and the clavicle. Finally the entire width of the pectoralis major was divided. The cyst was then found to press forward from beneath the clavicle. The axillary vessels and the brachial plexus were pushed forward. The cyst had extended beneath the pectoralis minor, and also in front of it so that it enveloped it. It

was multilocular, the locules having walls of different thicknesses and varying in size from a pullet's egg down. In some places the walls were very thin indeed so that these cysts ruptured on pressure. It was found that this growth extended well upward into the neck, portions of it being found beneath the lower portion of the sternomastoid muscle. The general appearance of the growth at the time of operation is indicated in Fig. 7, which was constructed from a sketch made by Dr. E. H. Pool at the time of operation. The cysts which broke contained thin serous fluid slightly yellowish in tinge. The growth extended over so far to the left as to involve the capsule of the shoulder-joint, and in the course of the dissection this joint was opened. It was manifest that it had the power of independent growth. The manner in which the clavicle was pushed forward, the axillary vessels and the brachial plexus were separated from it, the pectoralis major was pushed forward under strong tension, the pectoralis minor was enveloped both in front and behind, all gave evidence of a mass which was pushing its way along these tissues and following the line of least resistance.

This child made a reasonably good recovery from the operation and went home in a month.

At a later time in the winter he developed a sore throat with laryngeal obstruction and died.

Dr. Wm. C. Clarke, the pathologist of the hospital, was present at the operation and stained a part of the cyst wall with protargol as soon as it was removed, thus hoping to determine the character of the lining cells. A very beautiful endothelial lining was thus shown (Fig. 8). His report is here given.

Pathological Report.—J. A., 2293. February 5, 1913.

Gross Examination: Specimen consists of a sharply outlined lobulated oval tumor mass measuring 6 x 8 cm. Attached to this mass are two collapsed sacs of tissue; their walls are at points thin, elsewhere reinforced by considerable adventitious tissue.

Extending inward from the walls of the cavities are folds or reduplications that form compartments. These compartments or recesses connect with the main cavities of the sacs and are also crossed by numerous trabeculæ. There are other smaller cysts in these partitions. The content of these smaller unopened cysts is straw colored fluid.

The lining membrane of all the cavities is smooth and glistening. The substance of the sac wall is soft and resilient. This tissue is red, does not contain exudate, and there are no inflammatory signs present.

The uncollapsed mass on cut section is also found to be a cyst. The walls are 0.4 cm. in thickness. The tissue forming the wall is light in color and contains a small amount of inflammatory exudate. The cyst itself contains coagulated, clear, jelly-like exudate with radiating striations in the mass. This coagulated exudate is firmly adherent to the lining of the cyst cavity. Because of this, the lining of the wall is roughened and shaggy in appearance, not smooth and glistening as in the other cysts of the specimen. This portion of the specimen suggests that the cyst wall had been recently inflamed. Since the exudate as it poured out contained fibrinogen, fibrin was thrown down and the jelly-like coagulum resulted.

Microscopic Examination: Flat sections were stripped from the lining of the cyst cavities and were impregnated with protargol. Following precipitation of the silver salt in the sunshine, it was found that all but the cyst that contained coagulated exudate was lined by completely specialized endothelium.

The salt was precipitated in such a manner that a mosaic, was formed of black lines of silver. This mosaic defined the margins of the lining cells, showing that they covered the surface in an even and distinct layer characteristic of the lining endothelium of established blood or lymph channels, and not characteristic of connective tissue lined cavities, as in a joint or bursa for example.

Sections from wall of uncollapsed cyst show a definite connective tissue stroma resting on striated muscle bundles. The lining of the cyst is covered by dense masses of fibrin in the meshes of which are many leucocytes and well preserved red blood cells. The actual lining cells of the cyst are elongated fibroblasts which infiltrate the attached fibrin. Where the fibrin is deficient the lining cells are flattened and evenly disposed with no tendency to project outward into the cyst cavity.

Sections from the walls of the sacs which had contained clear fluid show that the cells are flattened out and present a distinct cell wall corresponding to the tangential sections of the silver preparations. At points in the cyst walls are many cavities containing dense masses of red blood cells and apparently no fibrin. The outline of these cavities is sharp and distinct with no tendency on the part of the lining cells to grow in among the red blood cells.

Pathologist, William C. Clarke, M.D.

CASE III.—W. F., aged eleven months. St. Mary's Free Hospital for Children, History No. S. 10949. Jan. 18, 1913. Patient sent by Dr. Leonard Adair. At birth a slight protrusion was noticed on right side of neck. It has been gradually increasing, especially since a cold appeared ten days ago. Now there is a large cystic swelling on the right side of neck extending from clavicle, acromion and border of scapula up two-thirds of the way to ear, looks as though it contains 6 oz. of fluid. Child looks

fairly well nourished. The child went to the hospital with a temperature of 103° , this temperature subsided, but at the time of operation he had a temperature of 101° .

Operation (January 21).—A long transverse incision was made and the fatty subcutaneous tissue was found to be œdematous. The cyst wall was not as definitely limited as if this œdema had not existed but it was fairly well dissected out. It extended forward to the sternomastoid muscle above the clavicle and behind its border. It extended backward under the trapezius and was so intimately adherent to the scaleni muscles that they were separated from it with great difficulty. Some of the branches of the cervical plexus were adherent in the wall of the growth. The posterior branch of the eleventh nerve could not be found.

An opening was made into the cyst wall fairly early in the operation and several ounces of pus exuded, this was reasonably thick, greenish in color and contained no coagulæ. When the mass was removed a smooth friable lining was found in its cavity. There were no lymph nodes apparent. The wound was partially closed, and drained. It healed satisfactorily and the child left the hospital two weeks after the operation.

Bacteriological examination of the pus showed both pneumococci and streptococci.

The microscopical examination of the cyst wall is given below.

Pathological Report.—W. F., 2292. February 5, 1913.

Gross Examination: Specimen consists of a sac wall the outer structures of which are fat and recent tissue. At one point the wall is distinct and free from fat.

The sac wall over the larger part of the specimen is 1 cm. in thickness diminishing from this extreme measurement to 2 mm.

The inner surface is exceedingly smooth and presents several folds and trabeculæ which partially subdivide the cavity. This inner lining is also exceedingly friable.

Cut section of the more solid portions of the wall show that there are two minute white areas in the lining of the main cavity. The tissue itself is yellowish pink with areas of fat.

There are no areas of definite degeneration. Sections of wall removed in fresh state and impregnated with protargol. After precipitation of the silver salt by sunshine, microscopic examination of lining showed that there were indifferent markings of silver but no distinct cell outline.

Hæmatoxylin and eosin stain of cross section of cyst wall shows that

it consists of granulation tissue. This granulation tissue is infiltrated with countless leucocytes and fibrin strands.

There are no areas of degeneration, no giant-cells and no epithelioid cells.

Microscopic examination of lymph node adjacent to cyst wall shows simple hyperplasia.

Diagnosis: Cyst of neck acute inflammation.

Pathologist, William C. Clarke, M.D.

CASE IV.—J. F., aged two years. St. Mary's Free Hospital for Children, History No. S. 11450. April 1, 1913. At birth there had been a slight "bubble like" swelling in the left side of the child's neck. This had increased during the last few months and had been treated by several doctors. One of them had drawn off considerable clear fluid by aspiration but the cyst had quickly filled again.

Physical Examination.—There was a cystic tumor on the left side of the neck which extended from behind the sternomastoid muscle forward almost to the median line and from the mastoid process nearly to the clavicle. This was very near the skin in some places and was apparently very thin walled. It fluctuated on pressure; there was no inflammation and the skin was not discolored over it.

Operation (April 1, 1913).—Transverse incision which had to be carried across the sternomastoid muscle. This muscle was divided. The cyst was multilocular, very thin walled, dark looking in places and extended up into the interstices of that portion of the neck. In removing it the internal carotid and internal jugular veins had to be separated for two inches or more. The internal jugular vein was liberated from it with great difficulty as it was densely adherent to it. The pneumogastric, phrenic and spinal accessory nerves were exposed for long distances. The cyst walls were attached firmly to the deep aponeurotic structures of the neck and the dissection went well down to the transverse processes of the cervical vertebræ, exposing the branches of the cervical plexus as well as the nerves previously mentioned. Apparently it was completely removed, but certain portions of the hygroma were so thin walled and the loculæ so small that their delicate structure could not always be distinguished from the normal tissues and it is possible that some little portions remained behind.

Wound was closed and child made a good recovery.

Pathological Report.—J. F., age two years. Specimen No. 2444. St. M., No. 1371. April 2, 1913.

Gross Examination: Specimen consists of a sharply outlined lobulated tumor mass somewhat oval in shape and measuring about 5.5 ± 4 cm. Extending from the surface of this mass are a number of small thin and transparent walled cysts which in one area are joined together forming a chain. These small cysts are bound together as well as to the main tumor mass by strong bands of adventitious tissue. Attached to the tumor are two greatly enlarged lymph nodes.

The main cavity of cyst is divided by means of folds into a series of smaller cavities or compartments. Traversing these compartments are a number of fine strands or trabeculae. The cysts contained a thin serous straw colored fluid.

The main cyst is lined by a smooth, glistening, pearly membrane. The sac wall is soft, elastic and very dense.

On sectioning one of the uncollapsed and smaller cysts the wall, though very thin, is found to be extremely dense and containing under considerable pressure a thin serous fluid.

The lining membrane of these cysts is similar to that of the larger one, namely, consisting of a pearly white membrane very smooth and glistening. There is no inflammatory reaction around the tumor. Specimen dissected from lining wall of cyst was impregnated with protargol.

Microscopic Examination: Tangential sections show the silver salts deposited in the intercellar cement substance giving to the tissue a mosaic appearance. The cells are seen to be highly specialized endothelial, similar to that seen lining the inner surface of blood and lymph vessels. The cyst wall is composed of a very definite connective tissue stroma, with no signs of inflammation.

Diagnosis: Hygroma.

Pathologist, Wm. C. Clarke, M.D.

One who studies these cysts must be impressed by two facts:

1. Their endothelial structure and multilocular development differentiate them from any of the other growths which are found in this locality.

2. They had an independent power of growth which was sufficient to force them with great power into the surrounding tissues.

The beautiful endothelial cells which existed in the second and fourth cases are shown in Figs. 8, 14 and 15, and a cross section of the endothelial structure which existed in the first case is shown in Fig. 3. Although a cross section does not show all the details of endothelium the cyst lining shown in

Fig. 3 very closely resembles that shown in Fig. 9. These linings differ from the epithelial linings which are found in branchial cysts and do not correspond to the tumors which are found in connection with ordinary lymph nodes. The structure is much more definite than one would find in an ordinary malignant tumor. The endothelial structure resembles that which is found in lymphatic vessels or in certain blood-vessels. It does not look like that which is found in joints or bursæ or which is developed in ordinary connective tissue.

We may dwell a little more at length on the enormous growing power which these cysts showed. The first one had worked its way forward above the clavicle and pushing around the internal border of the sternomastoid muscle had pushed downward behind the clavicle and behind the sternum, forming a saddle bag shaped cyst. When the child coughed and forced the fluid from the internal into the external part of this cyst the effect was startling. The external part of this cyst is indicated in Figs. 1 and 2. The communication between the two parts was large enough to easily admit the finger and the internal part extended for a wide distance behind the sternum into the mediastinum. The pressure force which carried it there must have been very great. When the external part of the cyst was removed and the pressure thus relieved, its internal part collapsed and healed and was not to be found at the second operation.

The growing power was shown again by the rapid recurrence between the two operations. Apparently all but the mediastinal part of the growth had been removed at the first operation, yet at the second operation, twenty-five days later, there was a multilocular thin walled cyst almost as large as the first one. The growth was as rapid as that of a very malignant tumor. The growth of the cyst in the second case had progressed with similar force. The way in which it pressed down into the axilla and enveloped the pectoralis minor muscle was remarkable. The first one formed a saddle bag cyst around the sternomastoid muscle, the second one formed a similar saddle bag cyst around the pectoralis minor muscle and pushed the pectoralis major forward so as to make

FIG. 1.



Cystic hygroma of neck. This cyst was multilocular. One portion extended around the lower inner border of the sternomastoid muscle into the mediastinum and formed a saddle-bag shaped cyst. Expansion could be noticed in the outer part when the child coughed. It contained clear fluid and was apparently lined with endothelium.

FIG. 2.



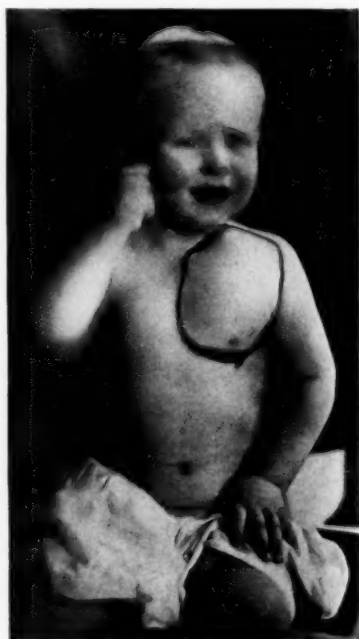
Posterior view of cyst shown in Fig. 1.

FIG. 3.



Cross section of cyst wall, Case I, showing lining which is believed to be endothelium a fibrous cyst wall, and round-celled infiltration.

FIG. 4.



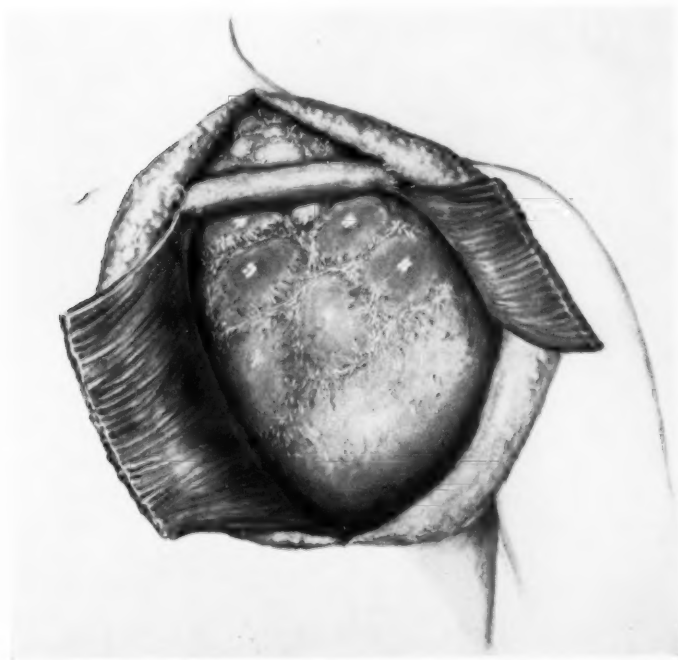
Case II. Cystic hygroma of neck and chest. The iodine mark indicates the boundaries of the cyst.

FIG. 5.



Case II. Cystic hygroma of neck and chest, side view. The growth extended under the pectoralis major muscle and pushed it forward.

FIG. 6.



Case II. Diagram of cyst from drawing made at time of operation (by Dr. Eugene H. Pool). The pectoralis major muscle has been divided and laid back from each side so as to expose the cyst *in situ*. The thoracic portion of the cyst seemed more recent than the cervical portion.

FIG. 7.

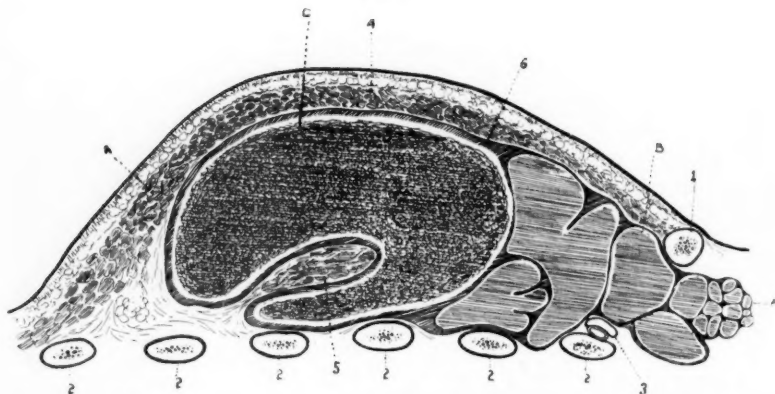


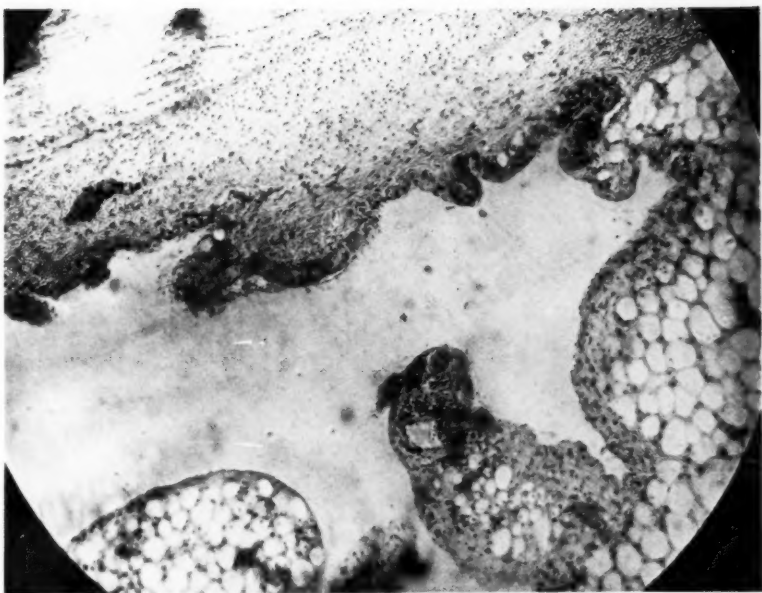
Diagram of vertical section of anterior chest wall and hygroma. (From drawing made by Dr. Wm. E. Clarke.) 1, Clavicle; 2, ribs; 3, axillary vessels; 4, pectoralis major muscle; 5, pectoralis minor muscle; 6, wall of cystic hygroma; A, small cysts in neck; B, larger cysts between clavicle and chest wall; C, cyst which had pushed in front and behind pectoralis minor muscle in saddle-bag shape. There were cocci and small round-cell infiltration in the wall of this portion of the cyst and there was fibrin in its content. Inflammation was thus indicated.

FIG. 8.



Case II. Cyst lining stained with protargol, showing delicate outlining of endothelial cells.

FIG. 9.



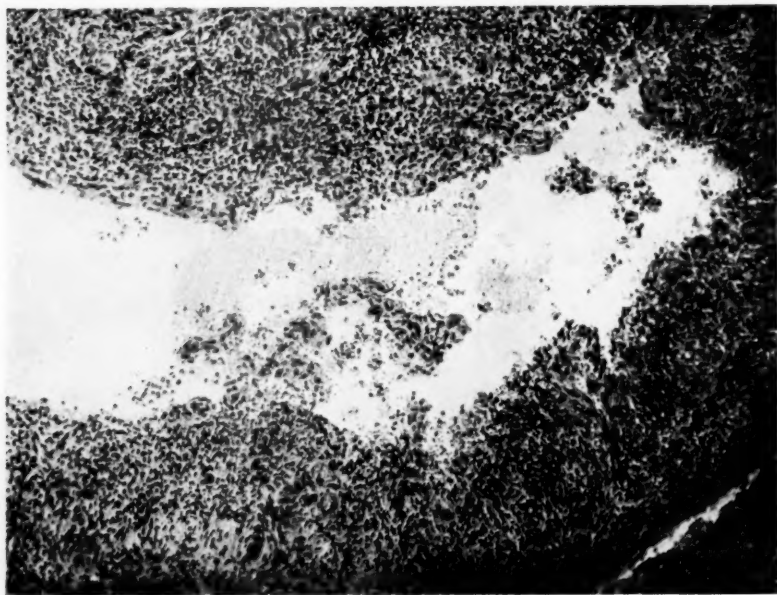
Case II. Cross section of cyst wall, showing endothelial lining, fibrous structure of wall and slight round-celled infiltration. This section is very similar to Fig. 3.

FIG. 10.



Case III. Believed to be hygroma of neck in which inflammatory changes had occurred. The history of the patient and the appearance of the cyst indicated "hygroma," but inflammation had so changed the cyst walls and contents that the original structure could not be definitely determined.

FIG. 11.



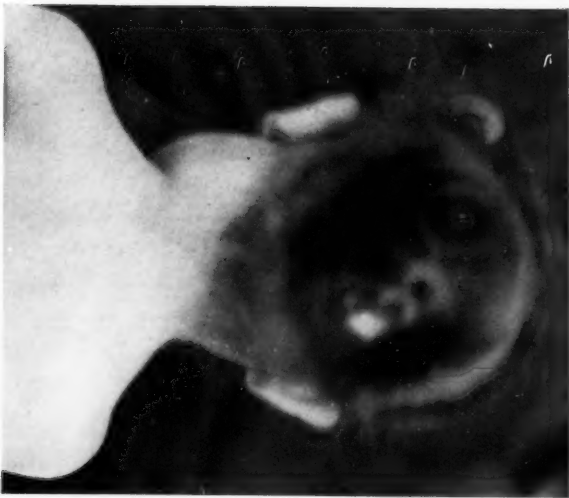
Case III. Cyst wall, showing extensive inflammation and small round-celled infiltration and disintegration of the cyst lining.

FIG. 12.



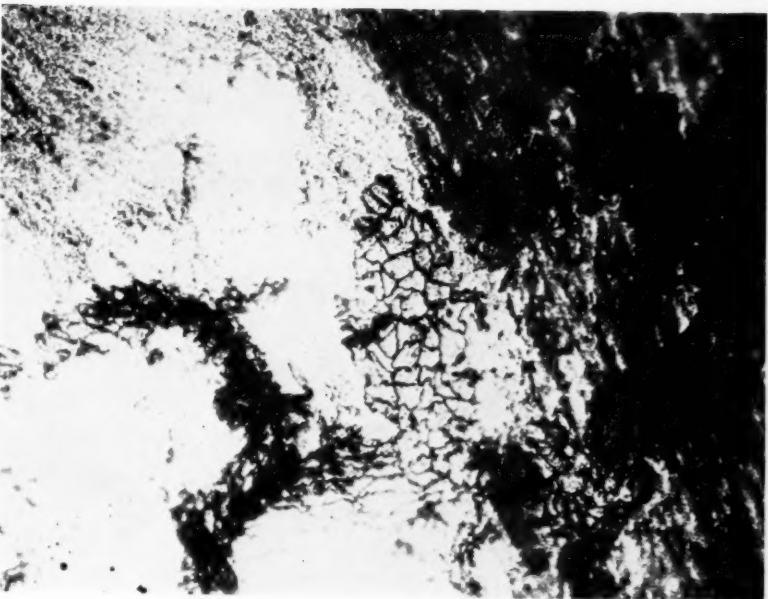
Case IV. Cystic hygroma of neck, child aged two years. A small cyst was present at birth and had recently increased in size. Clear fluid had recently been aspirated but the growth had continued. The endothelial lining of this cyst is shown in Figs. 14 and 15.

FIG. 13.



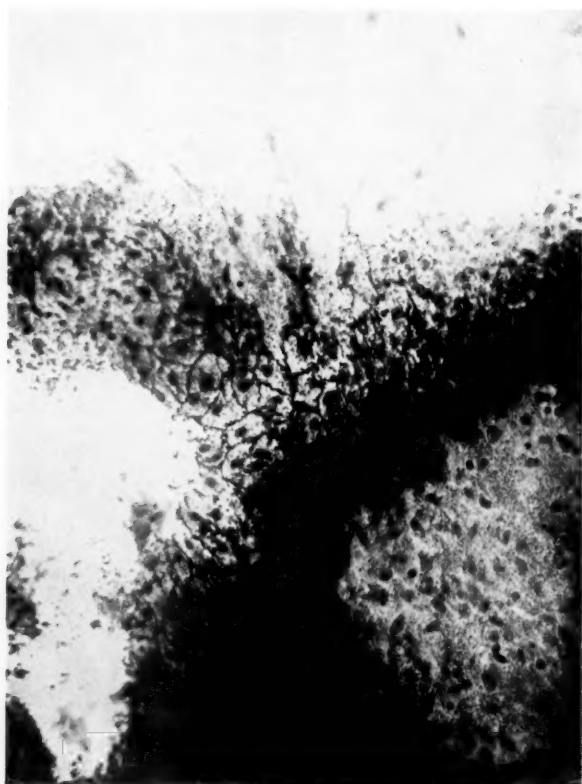
CASE IV. Rear view.

FIG. 14.



Microphotograph of portion of cyst wall from Case IV. The outlines of the endothelial cells are marked by protargol stain.

FIG. 15.



Portion of cyst wall from Case IV. The outlines of the endothelial cells are stained by protargol, their nuclei are stained by hæmatoxylin.

a great protrusion on the anterior chest wall (See Figs. 4, 5 and 6).

The peculiarities of the cyst growth were well shown in the second case. The translucent loculi, which apparently were the most recently formed, contained clear serum and had very thin walls with delicate endothelial lining; on the other hand, there was at least one other loculus which showed in its wall inflammatory infiltration of small round cells and the presence of cocci; its contents were coagulated and jelly-like.

The wall of the cyst in the first case also showed inflammatory thickening.

The presence of inflammation in the walls of these two cysts suggests an explanation for the more extensive inflammation in the wall of the cyst in the third case.

All of these cysts corresponded to the ordinary method of development which has been described, in that there was a small bubble-like growth at birth which was almost quiescent for many months and which then took on rapid growth.

Etiology.—One's curiosity must be excited by the presence of these cysts. In order to explain them one must account for cystic lymphatic tissue which was present at birth, which was nearly quiescent for a long period and which then took on rapid forceful growth.

Max Borst,¹ has given a résumé of our knowledge on the subject. He states that their cause is not entirely clear. Luschka and Boucher consider them as arising from the intercarotid ganglion. Arnold opposed this and thought it a cystic development of the connective tissue. Others thought they were connected with the thyroid. Gurlt and Rohitansky, a subcutaneous hydrops. Lucke, Koster, Klelos, an endothelial cyst arising from lymph vessels.

He suggests the presence of a congenital sequestration as the cause.

Arnold² who studied the subject most thoroughly as far back as 1865 thought that a congenital defect underlay the condition.

¹ Die Lehre von den Geschwülsten, Weisbaden, 1902, p. 204.

² Virchow's Archiv, 1865.

It is to this theory of an embryonic sequestration that I will particularly ask attention. A sequestration of lymphatic tissue which had in it an independent power of irregular growth offers a satisfactory explanation for all the conditions found.

It is unnecessary before this audience to review the entire question of embryonal sequestrations or rests. All here know that in the growth of the body fragments may be separated from the main portion of any one of the organs and that the closure of embryonic ducts or the development of other embryonic structures may be incomplete. The sequestrations or rests thus remaining may under certain conditions develop in irregular ways. Thyroglossal, branchial, dermoid, ovarian, parovarian, mesenteric or urachal cysts may be examples of such growth. Sometimes the growth seems little more than the distention of closed ducts owing to the activity of the epithelial cells which line it. At other times the growth is more active than this, *e.g.*, the semi-malignant growth of misplaced portions of the suprarenal bodies.

If we study the comparative anatomy of the lymphatic system we find many reasons for expecting occasional lymphatic rests. In fishes³ for instance the lymph vessels are not so plainly differentiated from the venous system as in the higher forms—a lymph sinus connected with a vein occurs on either side in the scapular region and into it lymphatic trunks from the head and body open.

Huntington, of Columbia, and McClure, of Princeton, have given much study to the comparative anatomy of the lymphatic system. The jugular lymph sac, depicted in Fig. 16, is a structure found in many animals and might well give rise to a sequestration in its development.

Professor McClure who has seen some of my specimens writes as follows:

"I think there can be no doubt about the cystic growths you speak of being due to embryonic sequestrations of lymphatic tissue.

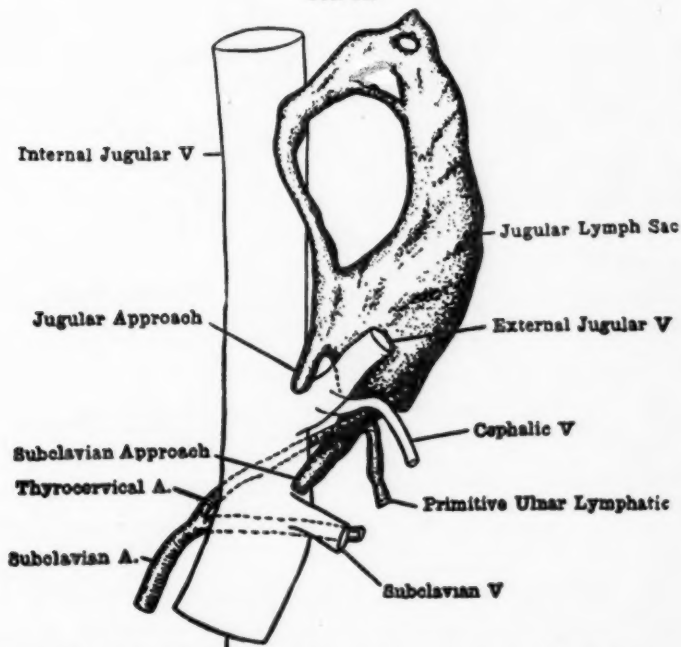
³ Wiedersheim, Comparative anatomy of Invertebrates, MacMillan, 1907, p. 432.

"Both Huntington and I have found that the lymphatics in the neck region of mammals develop as independent structures which secondarily connect with the veins. In certain cases some of these independent structures may never join the vein and give rise to the structure you mention. I have found the same condition in fishes, so one may regard this principle of development as uniform for vertebrals in general."

Fig. 17 shows an arrangement well adapted for the production of sequestrations.

The literature of the subject of hygromas throws much

FIG. 16.



A reconstruction of the left jugular lymph sac of a 11 mm. cat embryo (*Felis domesticus*). Reproduced from Anatomical Record, vol iii, p. 535 (McClure and Silvester).

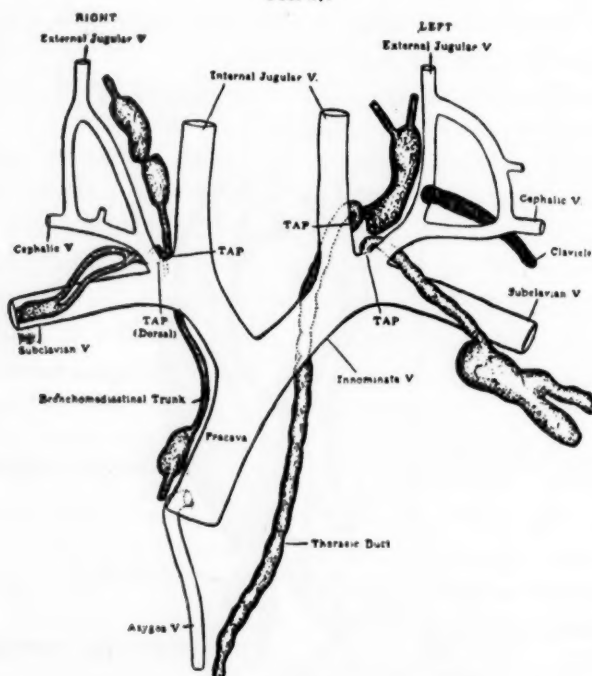
light on the peculiarities of their occurrence and strengthens our belief in the method of development above given.

Dr. Farr has made out the following tables endeavoring to include only those cases which were definitely hygromas, according to the definition above given. It is not possible to make a list which is altogether satisfactory, *e.g.*, in only 15 of the 91 cases in the first table is there a definite state-

ment of the endothelial lining of the cysts and we do not know how well the staining was done in most of these 15 cases.

The group division here given is about what would be expected. The neck is the part of the body most richly supplied with lymphatics and hence the most common site of these

FIG. 17.



Showing the structure of the lymphatics and their communications with the veins in the Pig-tailed Macaque (*Macacus nemestrinus* Linn). Reproduced from *Anatomical Record*, vol iii, p. 551, Fig. 9 (type 11) (McClure and Silvester).

growths. The axilla which also has a rich lymphatic supply shows the next largest number. Without doubt some of the axillary growths pressed through from the neck as in the writer's second case or were associated with the neck cysts as in Case 1.

It is a little strange that so few cases are reported in the groin but there are enough to establish their existence.

It is also noteworthy that so little of the literature is recent. Most of the recent cases are described under the

HYGROMA CYSTICUM COLLI.
Table of Reported Cases of Hygroma. Prepared by Dr. Charles E. Farr.

No.	Author	Age	Sex	R. L.	Operation	Autopsy	Result	Contents	Un- locu- lar	Multi- locu- lar	Radio- lum	Reference
1	Arnold	1 wk. Postus	M.	++	Repeated puncture	++	d.	Fluid serum	+	++	++	Virchow, Archly., 1865, Bd. 33, p. 209.
2	Arnold	8 mo.		++			c.			++	++	Virchow, Archly., 1865, Bd. 33, p. 209.
3	Hawkins	1 yr.		++			c.			++	++	Medico-Chir., Tr., 1839, v. 22, p. 231.
4	Hawkins	1 yr.		++			c.			++	++	Medico-Chir., Tr., 1839, v. 22, p. 231.
5	Arnott	1 mo.	F.	++	Puncture and excision	++	c.			++	++	Medico-Chir., Tr., 1839, v. 22, p. 231.
6	Arnott	1 mo.	F.	++	Puncture and excision	++	c.			++	++	Medico-Chir., Tr., 1839, v. 22, p. 231.
7	Nelaton	N. B.		++	Puncture and excision	++	c.			++	++	London M. Gazette No. 3, v. 1, 1839, p. 917.
8	Lorain	N. B.	M.	++	Punctures	++	d.			++	++	Gazette d' Hôpt., 1854, No. 78, p. 310.
9	Storch	4 wks.	M.	++	Punctures	++	d.			++	++	Gas. med. d. Paris, 3 Ser., T. viii, 1853.
10	Bruch	N. B.	M.	++	Punctures	++	d.			++	++	P. f. Kinderkrankheiten 1861, p. 68.
12	Evans	1 yr.	M.	++	Seton	++	c.			++	++	Zeitach. f. Rat-med., Bd. 8, p. 91.
13	Roux	3 mos.			Incision		c.					Rec. Med. chir., 1855.
14	Gilles				Excision		d.					Dissertation, Bonn, 1852.
15	Roux, J.	8 d.	M.	++	Excision	++	d.			++	++	Bull. Gen. de Therap. v. 51, p. 455.
16	Roux, J.	15 mos.	M.	++	Injection iodine	++	c.			++	++	Bull. Gen. de Therap. v. 51, p. 456.
17	Ebermaier	2 mos.	F.	++	None	++	d.	Bloody serum		++	++	Caspar's Wehn, 1836, p. 13.
18	Wutzer	11 d.	M.	++	Puncture	++	d.			++	++	Caspar's Wehn, 1836, p. 257.
19	Volckers	14 d.	F.	++	Puncture	++	d.	Clear serum		++	++	Caspar's Wehn, 1837, p. 704.
20	Bednar	55 d.	F.	++	Incision	++	d.			++	++	Krankheit de Neugebor., 1850.
21	Bouchut	21 d.		++	O	++	d.			++	++	Kinderkrankheiten, 1854, p. 786.
22	Berend	12 w.		R	Puncture and iodine	++	Imp.			++	++	Med. Zentral-Zeit., 1861, p. 286.
23	Ebert	7 yrs.	M.		Puncture and iodine		Imp.			++	++	Med. Zentral-Zeit., 1861, p. 286.
24	Ammon	N. B.		+	O	+	d.	Red serum	O	+	+	Angeboren. Chir. Krankheit., 1842, p. 54.
25	Droste	N. B.	F.		Seton		c.			+	+	Halsisches Hannover Annal., 1839, p. 295.
26	Scholz	22 yr.	M.	+	Partial excision		c.	Clear serum	+	+	+	Wien. Med. Wochn., 1863, v. 13, p. 612.
27	Schub	N. B., few mos.		+	Excision					+	+	Path. and Therap. d. Pseudoplasma, 1834, p. 196.
28	Werther	N. B.	F.	+	Spont. rupture O	+	c.			+	+	Angeborene Cystenhygroma, 1843.
29	Ammon.	1 yr.		+			Unchanged			+	+	Angew. Chir. Krankheit., 1892, p. 57.
30	Redenbacher	N. B.		+			d.			+	+	Dis. München, 1828.
31	Otto	N. B.	M.	+			d.			+	+	Mont. Secent. Vratul, 1841.
32	Jackson	3 yrs.	M.	+	Excision	+	c.			+	+	Am. Jr. Med. Sci., 1861, p. 101.
33	Gurt	Postus	M.	+		+	d.			+	+	Cyst. Geschist des Halses, 1855.
34	Gurt	Postus	M.	+		+	d.			+	+	Cyst. Geschist des Halses, 1855.
35	Gurt	12 wks.	F.	+	Puncture		d.			+	+	Cyst. Geschist des Halses, 1855.

HYGROMA CYSTICUM COLLI.—Continued.

No.	Author	Age	Sex	R. L.	Operation	Result	Autopsy	Contents	Multilocular	Cyst Wall	Reference
36	Bednar	N. B.	F.	+	Puncture	d.	+	Serum	++		Krankheiten des Neugeborenen, 1850.
37	Adelman	5 wk.	M.	+	Seton	c.		Serum	++		Walther u Ammon fr. de Chir., 1850.
38	Zangenbeck	25 yr.	M.		Excision	c.		Serum	++		p. 237.
39	Koenig	25 yr.	F.		Excision	c.		Serum	++		
40	Nasse	25 yr.	F.	+	Excision	c.		Serum	++	Endothel'm	Archiv. f. klin. Chir., B. 38, 1889, p. 614.
41	Nasse	10 yr.	F.		Excision	c.		Serum	+	Endothel'm	Archiv. f. klin. Chir., B. 38, 1889, p. 614.
42	Nasse	2 yr.	M.	+	Excision	c.		Serum	+	Endothel'm	Arch. f. klin. Chir., B. 38, 1889, p. 614.
43	Nasse	11 yr.	M.	+	Excision	c.		Bloody serum	Unilocular	Endothel'm	Archiv. f. klin. Chir., B. 38, 1889, p. 614.
44	Kenson	5 mo.	F.	+	Excision	d.		Bloody serum	Multilocular	Endothel'm	Phil. Med. Jr., 1901, v. 8, p. 533.
45	Halstead and Herzog	22 mo	F.	+	Excision	c.		Bloody serum	Multilocular	Endothel'm	J. A. M. A., 1899, v. 32, p. 233.
46	De Quervain	Adult	F.	+					Multilocular		Spzielle Chir. Diag., 1913, p. 169.
47	Sicls	2 yr.	M.	+	Excision	c.		Bloody serum	Multilocular	Endothel'm	Virchow Archiv., 1903, Bd. 72, p. 445.
48	Carless	5 yr.	F.	+	Excision	c.		Serum	Multilocular	O	Med. Press and C., 1904, v. 1, p. 140.
49	Carless	3 d.	M.	+	Partial excision	d.		Serum	Multilocular		Med. Press and C., 1904, v. 1, p. 140.
50	Robinson	3 mos	M.	+	Partial excision	d.		Serum	Multilocular		Trans. Path. Soc., Lond., 1895-6, v. 47, p. 255.
51	Koester	N. B.	F.	+	Puncture	d.		Serum	Multilocular	+	Würzburger Abhand., 1872, Bd. II, p. 44.
52	Wölfler	3 yr.	F.	+	Incision	c.	+	Serum	Multilocular		Wien. Med. Press, 1886, B. 27, p. 906.
53	Pactzold (Garré)	5 wk.	F.	++	Partial excision	d.	+	Serum	Multilocular		Bruns Beiträge, 1906, No. 51, p. 652.
54	Pactzold	8 mo.	F.	+	Excision	d.	+	Bloody serum	Multilocular	+	Bruns Beiträge, 1906, No. 51, p. 652.
55	Pactzold	13 mo.	M.	+	Excision	c.		Bloody serum	Multilocular		Bruns Beiträge, 1906, No. 51, p. 652.
56	Pactzold	3 yr.	M.	++	Excision	c.		Bloody serum	Multilocular	+	Bruns Beiträge, 1906, No. 51, p. 652.
57	Pactzold	2 yr.	F.	++	Excision	c.		Blood and ser.	Multilocular	+	Bruns Beiträge, 1906, No. 51, p. 652.
58	Pactzold	37 yr.	F.	++	Excision	c.		Serum	Unilocular	O	Bruns Beiträge, 1906, No. 51, p. 652.
59	Trendelenburg	2 yr.	F.	++	Injection-iodine	d.		Brown serum	Multilocular		Archiv. f. klin. Chir., 1872, Bd. 13, p. 404.
60	Trendelenburg	9 d.	M.	+	Injection-iodine	c.		Serum	Unilocular		Archiv. f. klin. Chir., 1872, Bd. 13, p. 404.
61	Trendelenburg	1 d.	M.	+	Injection-iodine	c.		Bloody serum	Unilocular		Archiv. f. klin. Chir., 1872, Bd. 13, p. 404.
62	Winwarter	14 m.	M.	+	O	d.	Partial	Bloody serum	Multilocular	+	Archiv. f. klin. Chir., 1874, B. 16, p. 655.
63	Schwerin	N. B.	F.	++	Puncture of ranula	d.	+	Serum	Multilocular	No cylinder epithel'm	Archiv. f. klin. Chir., 1874, B. 23, p. 430.
64	Burrow				Partial excision	d.					Archiv. f. klin. Chir., 1871, B. 12, p. 979.
65	Burrow	14 m.		+	Drainage	c.		Serum	Multilocular		Archiv. f. klin. Chir., 1871, B. 12, p. 979.
66	Birkett	20	M.	R	Puncture repeated	Unim.		Clear serum	+		Med. Times and Gazette, 1868, II, p. 79.
67	Albert	Adult	M.	R	Puncture	d.		Serum	?		Lehr. d Spec. Chir., 1897, Bd. I, p. 216.
68	Roberts	3 yrs.	M.	L	Excision	d.		Serum	+		Phil. Med. Times, 1875, Mar. 13, p. 372.

No.	Name	Age	Sex	Operation	Result	Remarks
69	Boinet					
70	Robert	N. B.	M.	Puncture	Serum	Bull. d. I. Soc. d Chir., d Paris, 1859, x, p. 222.
71	Broca	N. B.	F.	Punc. and Excis.	Serum	Bull. d. I. Soc. d Chir. d Paris, 1859, x p. 222.
72	Gullaumet	Fœtus		O	Bloody serum	Bull. d. I. Soc. d Chir. d Paris, 1859, x p. 222.
73	Hardie	5 m.	F.	L. Excision	Serum	Bull. d. I. Soc. anatomique, 1879, ix 582.
74	Hogg	14 m.		Seton	Serum	Lancet, 1872, v. 2, p. 667.
75	Holmes	8 yrs.	M.	Excision	Serum	Lancet, 1873, v. 2, p. 812.
76	Hewitt	6 m.	F.	Partial excision	Serum	Med. Times & Gaz., 1864, v. 1, p. 76.
77	Smith	3 wk.	F.	O	Serum	St. Barthol Reports 1866, v. 2, p. 24.
78	Smith	8 m.	F.	L. Seton	Serum	St. Barthol Reports 1866, v. 2, p. 31.
79	Smith	3 yrs.	F.	R. Seton	Serum	St. Barthol Reports 1866, v. 2, p. 31.
80	Smith	Infant	F.	L. Seton	Serum	St. Barthol Reports 1866, v. 2, p. 31.
81	Dittel	6 mo.	M.	L. Excised	Serum	St. Barthol Reports 1866, v. 2, p. 31.
82	Vallena	2 yrs.	M.	R. L.	Serum	Oster. Zeitschrift f. Prah, Heil, 1859, v. 81.
83	Devatz	N. B. 6 m.	M.	R. L. Punctured	Serum Bloody serum	Oster Handb. f Paediatrik, 1871, ii 35. Bull. et Mem d. I. Soc. d Chir. d Par. 1876, ii, 762.
84	Kumemüller	8 mo.		R. Cautey	Serum	Jahrbuch f. Kinderheit 1898, B. 48, p. 390.
85	Hofmühl	16 yrs.	F.	R. Excised	Serum	Archiv. f. Kinderheit 1887, viii, 220.
86	Parrot	2 m.	F.	O	Serum	Gaz. des Hôpit., 1880, p. 35.
87	Lannelongue	2 yr.		Puncture	Serum	Gaz. des Hôpit., 1880, p. 199.
88	Kocher	3 m.		Injection-iodine	Serum	Corresp. blat. f. Schweizer A. 1878, viii, 625.
89	Stolz	5 d.	M.	R. L. Puncture	Serum	Rev. Med. d L. Est., 1878 x, p. 161.
90	Lücke	4 d.		Puncture	Serum	Virchow Archiv. 33, 1865, p. 330.
91	Lücke	few wk.		O	Serum	Virchow Archiv. 33, 1865, p. 330.

HYGROMA CYSTICUM AXILLARE.

No.	Author	Age	Sex	R. L.	Operation	Result	Autopsy	Contents		Cyst Wall	Reference
1	Sandfort		F.	R. L.	Punctures	c.		Serum		Multilocular	Obs. Anat. path., v. iv, p. 21.
2	Hawkins					c.				Multilocular	London Med. Chir., Tr. v. 22, p. 236.
3	Toft		M.	R. L.	Puncture	c.					Lancet 1891, v. i, p. 1372.
4	James	5		R. L.	Excision	c.					Internat. Clin., 1903, 13, s. 1 p. 129.
5	Senn	5 mo.		L. L.	Excised	c.					Archiv. f. klin. Chir., 38, 1889, p. 614.
6	Nasse	8 yr.	F.	L. L.	Excised	c.					Archiv. f. klin. Chir., 38, 1889, p. 614.
7	Nasse	2 yr.	F.	R. L.	Excised	c.					Archiv. f. klin. Chir., 38, 1889, p. 614.
8	Nasse	3 yr.	F.	L. L.	Excised	c.					Archiv. f. klin. Chir., 38, 1889, p. 614.
9	Nasse	11 yr.	M.	L.	Excised	c.		Blood and serum			Med. Press & C. 1904, v. i, p. 140.
10	Koenig	6 yr.	M.	L.	Excised	c.		Blood and serum			Virchow Archiv. Bd 151, p. 392.
11	Carless	10 yr.	M.	R.	Excised	c.		Serum			Wein klin. Wchn, 1894, No. 7, p. 531.
12	Ribbert	4 d.			Puncture and excision	c.		Serum			Angeborener Cysten Hygrom, 1845, p. 488.
13	Rumbold										Über ein angeborener Cysten hygrom der achulhöhle, 1876.
14	Weinher	10 yr.		L.	Partial excision	d.	+	Serum		+	Wein klin. Wchn., 1894, No. 7, p. 533.
15	Verneuil	9 m.		L. L.	Excision	d.		Serum		+	Wein klin. Wchn., 1894, No. 7, p. 552.
16	Heschl	9 m.	M.	R. L.	Drainage	c.		Serum		+	Archiv. f. klin. Chir., xii, 1871, p. 685.
17	Rumbold	2 yr.	M.	L. L.	Puncture	c.		Serum		+	Bruns Beiträge, 18, 1897, p. 379.
18	Gjorgievic	2 m.	M.	R. L.	Excision	c.		Serum		+	Bruns Beiträge, 18, 1897, p. 379.
19	Brazis	7 w.	F.	R. L.	Excision	c.		Serum		+	Bruns Beiträge, 18, 1897, p. 379.
20	Brazis	2½ yr.	F.	L. L.	Puncture electrolysis excision	d.	+	Serum		+	Bruns Beiträge, 18, 1897, p. 379.
21	Brazis	15 yr.	M.	L.	O	c.		Serum		+	Jahrb Kinderheil n. F. Bd 16, 1881, p. 429.
22	Brazis	1 m.	M.	R.	O	c.		Serum		+	Med. Times & Gazette, 1868 v. 2, p. 79.
23	Anders	2 yr.				c.		Serum		+	Archiv. f. klin. Chir., xx, 1877, p. 674.
24	Birkett	28	M.	R. R.	Excision	c.	+	Serum		+	Archiv. f. klin. Chir., xx, 1877, p. 689.
25	Wegner	9 m.	M.	R. R.	Excision	c.		Serum		+	Bruns Beiträge Bd. i, 1883, p. 500.
26	Müller	2½ yr.	F.	R. L.	Excision	d.		Serum		+	Deutsche Chir., 1888, L. 42, p. 251.
27	Müller	1 yr.	M.	L. L.	Excision	c.		Serum		+	Central blatt f. Chir., 1886, p. 177.
28	Riedinger	35 yr.	M.	L. L.	Injection Zncl ₂	c.		Blood and serum		+	Bull. et Mem. d. i. Soc. de Chir. de Paris, 1878, p. 815.
29	Pinner	4 yr.	M.	L. L.	Excision	c.		Serum		+	Med. Times & Gazette, 1868, li, p. 79.
30	Pilate	2½ yr.				c.		Serum		+	Lehrb. d Spec. Chir., 1889, li, p. 40.
31	Birkett	7	M.	R.	Excision	c.		Serum		+	St. Barthol. Rep. v. 2, 1866, p. 32.
32	Koenig	Few mos.				Imp.		Serum		+	St. Barthol. Rep. v. 2, 1866, p. 32.
33	Smith	14 w.	M.	Post L.	Seton	c.		Serum		+	Bull. d. i. Soc. Anat. de Paris, 1892, p. 286.
34	Smith	2 yr.	F.	L.	Seton	c.		Bloody serum		+	
35	Dubar	4 m.	M.	L.	Excision	c.				+	

HYGROMA CYSTICUM (GENERAL).

Number	Author	Age	Sex	R. L.	Operation		Result	Autopsy	Contents	Multi-locular	Cyst Wall	Reference
1	Paetzold	4 d.	F.	+	Thigh and leg	Excision	c.		Lymph	+		Bruns Beitrage, 1906, No. 51, p. 652.
2	Hildebrand	1 m.	F.		Rectal sacral	Excision	d.	+	Lymph	+	Endothel'm	Archiv. f. klin. Chir. B. 49, 1894, p. 204.
3	Hildebrand	3 yr.	M.		Rectal sacral	Excision			Lymph	+	Endothel'm	Archiv. f. klin. Chir., B. 49, 1894, p. 204.
4	Reichel	1 m.	M.		Left perineum	Puncture incision	d.	+	Lymph	+	Endothel'm	Virchow. Archiv. 46, 1869, p. 497.
5	Müller	2 m.	F.		Lips, tongue, cheek	Excision	c.		Lymph	+		Bruns Beitrage, 1883, Bd. 1 p. 498.
6	Verneuil	7 yr.			Perineum	Excision			Lymph	+		Cruveilhier Anat. Path. Gen. T. iii, 1856, p. 498.
7	M. Deguise	18 yr.	M.		Abdominal wall	Excision			Lymph	+		Bull. d. I. Soc. d. Chir. d. Paris, 1857, T. 8, p. 459.
8	Morel-Lavallée			R.	Shoulder	O		+	Lymph	+		Bull. d. I. Soc. d. Chir. d. Paris, T. 10, 1859, p. 230.
9	Smith	16 m.	F.	R. & L.	Back of neck	O	Imp.			+		St. Barthol. Rep., v. 2, 1866.
10	Smith	3 m.	F.		Dorsal spine	O	Imp.			+		St. Barthol. Rep. v. 2, 1866.
11	Delbet	3 m.		R.	Orbital	Excision			Lymph	+		Bull. d. I. Soc. Anat. de Paris, 1893, p. 637.

heading of lymphangioma and it is difficult to sift out the cases which are really hygromas. Winglowski's ⁴ recent article should be referred to, he studied various neck anomalies and dissected 150 half necks in children and adolescents and found rests 23 times.

It would be very gratifying to explain the remarkable power of growth which these cysts have. Unfortunately we cannot do this with absolute accuracy any more than we can tell why some people grow to be large and others remain small. There are, however, many other instances of somewhat similar growth. Ovarian cysts, parovarian cysts, dermoid cysts, both abdominal and subcutaneous, hypernephromas, mesenteric cysts, thyroglossal and branchial cysts, lipomata, exostoses, growths of the carotid body, common warts are all examples of individual power of growth which comes in tissues otherwise benign. In view of these examples it is not strange that sequestrations of lymphatic tissue in the neck should occasionally show this great power of growth.

SUMMARY.—1. Cystic hygromas of the neck have been described for many years and their existence is undoubted.

2. The term should be restricted to cysts lined with endothelium and having a marked power of growth.

3. Such cystic growths are uncommon. A careful search of the literature has so far revealed records of only 91 cases located distinctly in the neck and 35 cases located principally in the axilla, but in part at least extending there from the neck.

4. The writer records three cases of undoubted hygroma and a fourth case which is believed to have been a hygroma but in which inflammation had destroyed the finer structure of the cyst walls.

5. The most satisfactory explanation of the existence of these hygromas is that embryonic sequestrations of lymphatic tissue existed and that they had the power of persistent irregular growth.

6. Excision is the best treatment. If this is impracticable partial excision is the next best.

⁴ Archiv f. Klin. Chir., 1912, vol. 98, p. 151.

EXCLUSION OF THE BLADDER, AN OPERATION OF NECESSITY AND EXPEDIENCY.*

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EXCLUSION of the bladder is an operation which has been slowly accepted by the medical profession, and while it is generally admitted that such an operation may be necessary and often is advisable, the mortality following the earlier procedures was at least detrimental to enthusiasm. However, there has been much more to overcome than mortality in the matter of sentiment and the so-called conservatism which urged the preservation of the bladder at any cost regardless of control or comfort.

The natural mortality in these cases, although high in deformities and assured in malignancy, was, at least, not the work of man. Oppel,¹ quoting Mirotworzeff,² gives the statistics as follows: "Seventy patients between 10 and 20 years, 10 deaths; between 20 and 40 years, 17 deaths; between 40 and 50 years, 5 deaths; one reached the age of 70 years." He states further that the natural mortality in cases of exstrophy of the bladder in children show that more than half die before the tenth year.

Within a comparatively recent period our interest in the subject has been revived by reports of many successful cases of exclusion of the bladder and with the improved technic of the various procedures. To determine the best method of disposal of the secretion of the kidneys in individuals in whom it is necessary or expedient to exclude the bladder, is still one of the serious problems of surgery. To say, however, that the modern operation exposes the patient to greater danger from infection than is compensatory with the mitigation of his suffering, together with the natural mortality of the disease, is not consistent with the history of the patients or the records of the progress of surgery in these

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cases. Unfortunately, many of the patients under discussion are already suffering from the secondary infective complications before operative measures are advised. The patients under discussion may be grouped under three headings (Fig. 1):

(1) Those suffering from congenital anomalies of the bladder or urethra of such character as not to permit restoration with controllable urine or who cannot be relieved from painful sequelæ by local surgical or other measures.

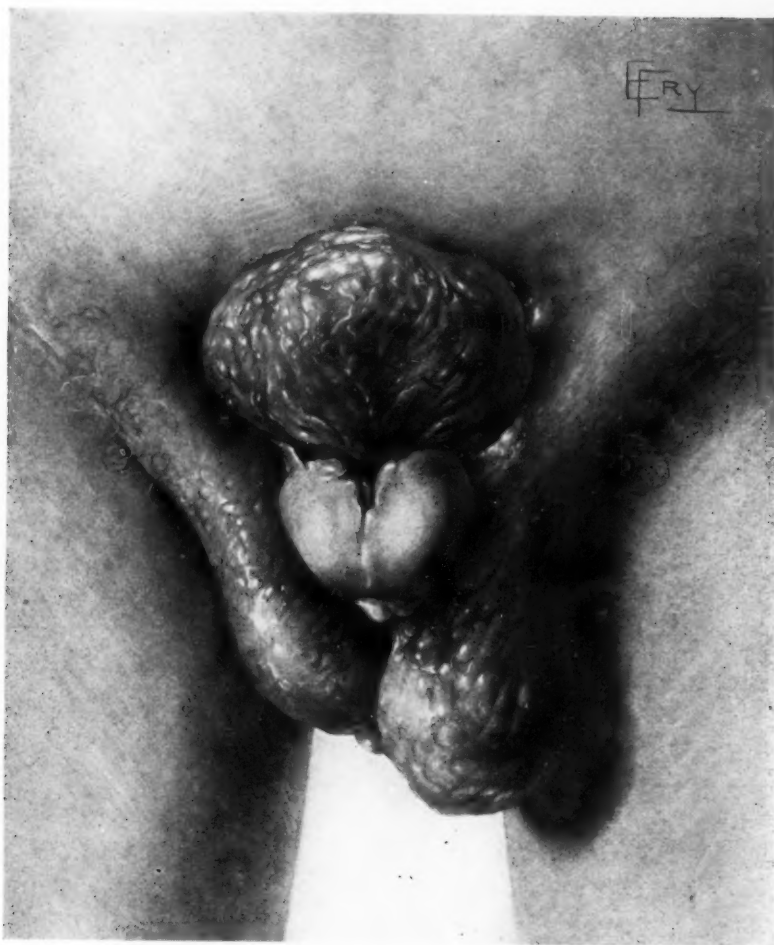
(2) Those in whom portions of the ureter are necessarily or accidentally injured or removed during abdominal, pelvic or sacral operations.

(3) Those in whom malignant disease of the urinary bladder is too extensive to permit removal by partial resection of the bladder with retentive function under control, and those in whom gross malignant or other disease of the bladder exists, but in whom the power of retention and control add to their suffering. These cases will necessarily be limited in number.

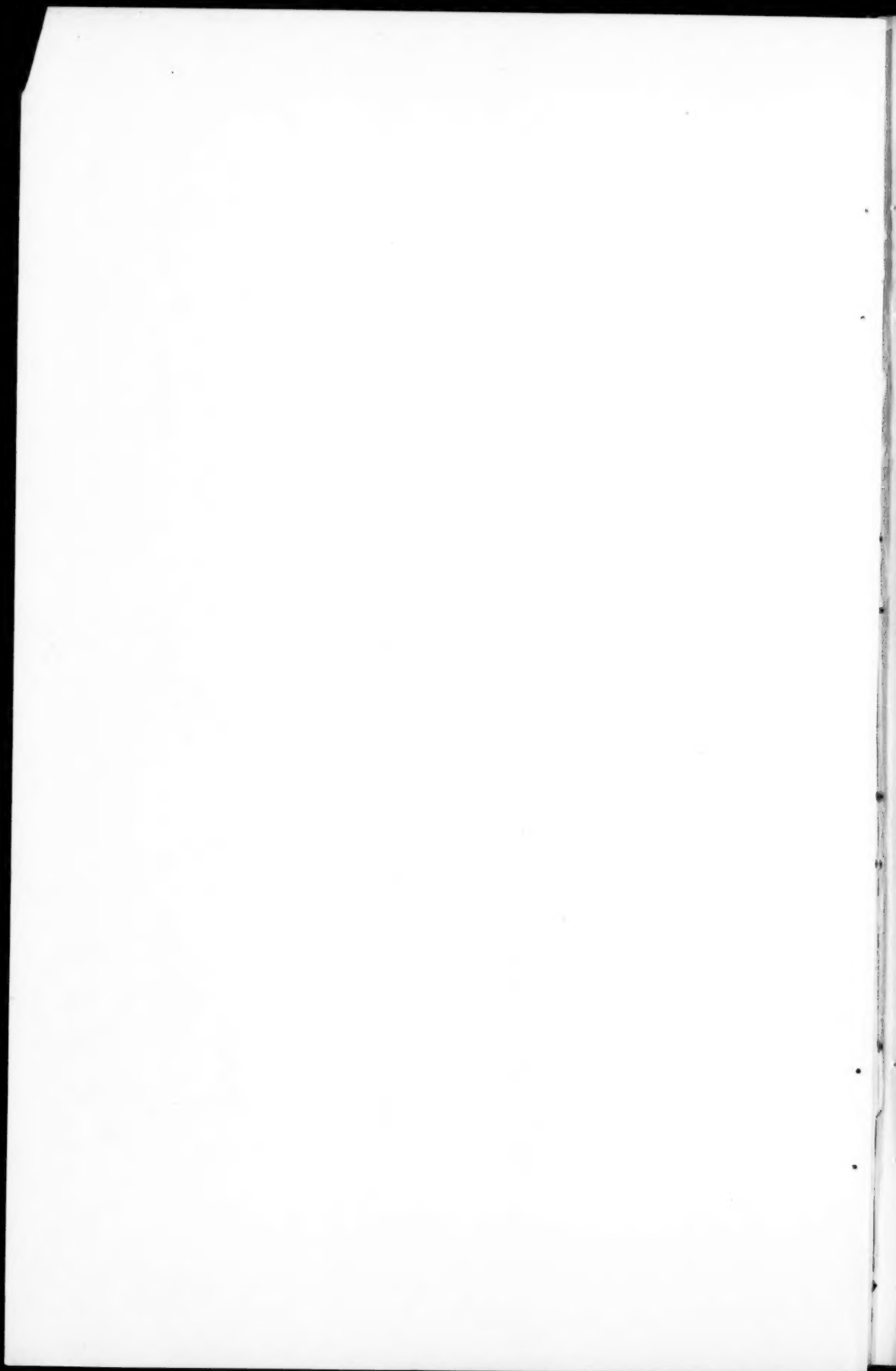
For the repair of the first group various surgeons have devised a wonderful variety of ingenious methods. Making a bladder from skin flaps was originated by Roux³ in 1852. Various modifications have been developed by Thiersch,⁴ Nelaton,⁵ Wood⁶ and many others. The compression of the bony pelvis (the anterior portion of which is usually missing) was instituted by Passavant,⁷ the breaking and subcutaneous section of lateral bony arches were devised by Koch,⁸ König⁹ and others, and Trendelenburg¹⁰ successfully accomplished the closure of the bladder, covering it with an anterior bony arch by freeing the sacro-iliac joints. Epispadias, especially in the female, which is so extensive as to cause a loss of urinary control, is also placed in this group, although a few of these cases may be benefited by local measures.

Excellent results have been claimed for the Goebel¹¹ method of providing a voluntary sphincter made from the pyramidal muscles. Ssubbotin's¹² method, in its effort to develop a bladder with control of the sphincter, is probably the most ingenious. It is especially applicable in males. An anterior incision is made within the anus, the space in front

FIG. 1.



Exstrophy of bladder in male. Exposed mucosa with ureteral openings.



of the rectum and within the sphincters is tunnelled up to reach the base of the bladder, a rectangular strip, of which the future urethra is made, is drawn down to protrude from the anal ring in the fore part of the rectal opening. The remainder of the bladder and the anterior part of the rectum is converted into a closed pouch, the control of which is contained in the rectal sphincter. The operative mortality in these cases is 25 per cent. and should the technic fail the patient is exposed to the loss of control of both bladder and bowel, since no other operation is then possible. The new bladder is exposed to infection by all the intestinal flora through its short urethra. The plan of Gersuny¹³ involved the same principle of utilizing the anal sphincter to control the open end of a separated loop of bowel to which the ureters were attached.

The objection to any method of operating for the repair of these defects which does not control urine automatically is a very serious one. Uncontrollability of the urine is only accepted by the patient who acquires the condition as the lesser of two evils—a greater one being the pain due to its retention or delivery. If an uncontrolled bladder be made from an exstrophy the patient is no better off, and, if anything, worse than a high epispadias, since the more perfectly an uncontrolled bladder is developed the more surely will it become infected or filled with stone or phosphatic concretions from the decomposing urine. He thus becomes more liable than before to an ascending infection and develops conditions which require the reopening of the bladder.

The cloacal condition, which exists normally in fowls and is also the condition which exists during the first weeks of the human embryo, early suggested the thought of making such a deflection of urine through the rectum. Such a method secured a retentive space under control, and was comparatively easy of accomplishment.

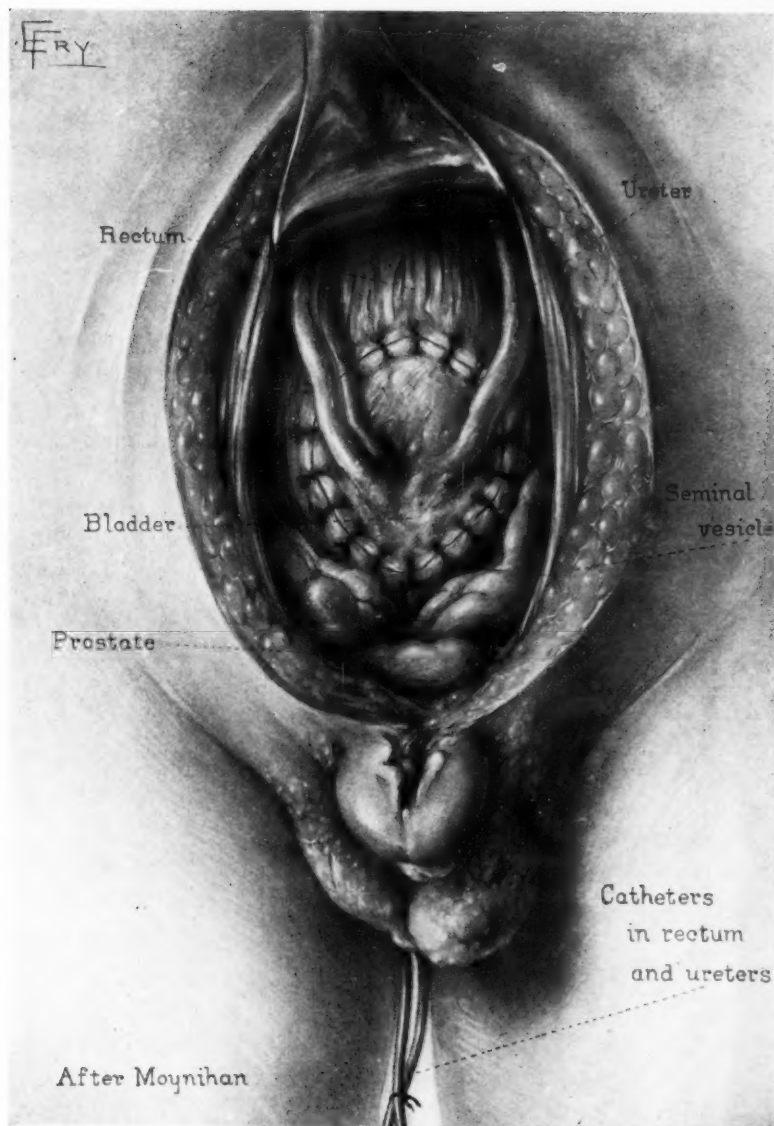
The high mortality from ascending infection of the kidneys through the ureters following the old methods of intestinal union made the procedure almost prohibitive, especially when complications were increased by shock and peritonitis.

Some of these patients were already debilitated by the infection of one and sometimes both kidneys or their pelves. Woolsey¹⁴ reported stones in both ureters in a case of exstrophy of the bladder and a patient with epispadias, having stones in the kidney, was observed in our clinic.

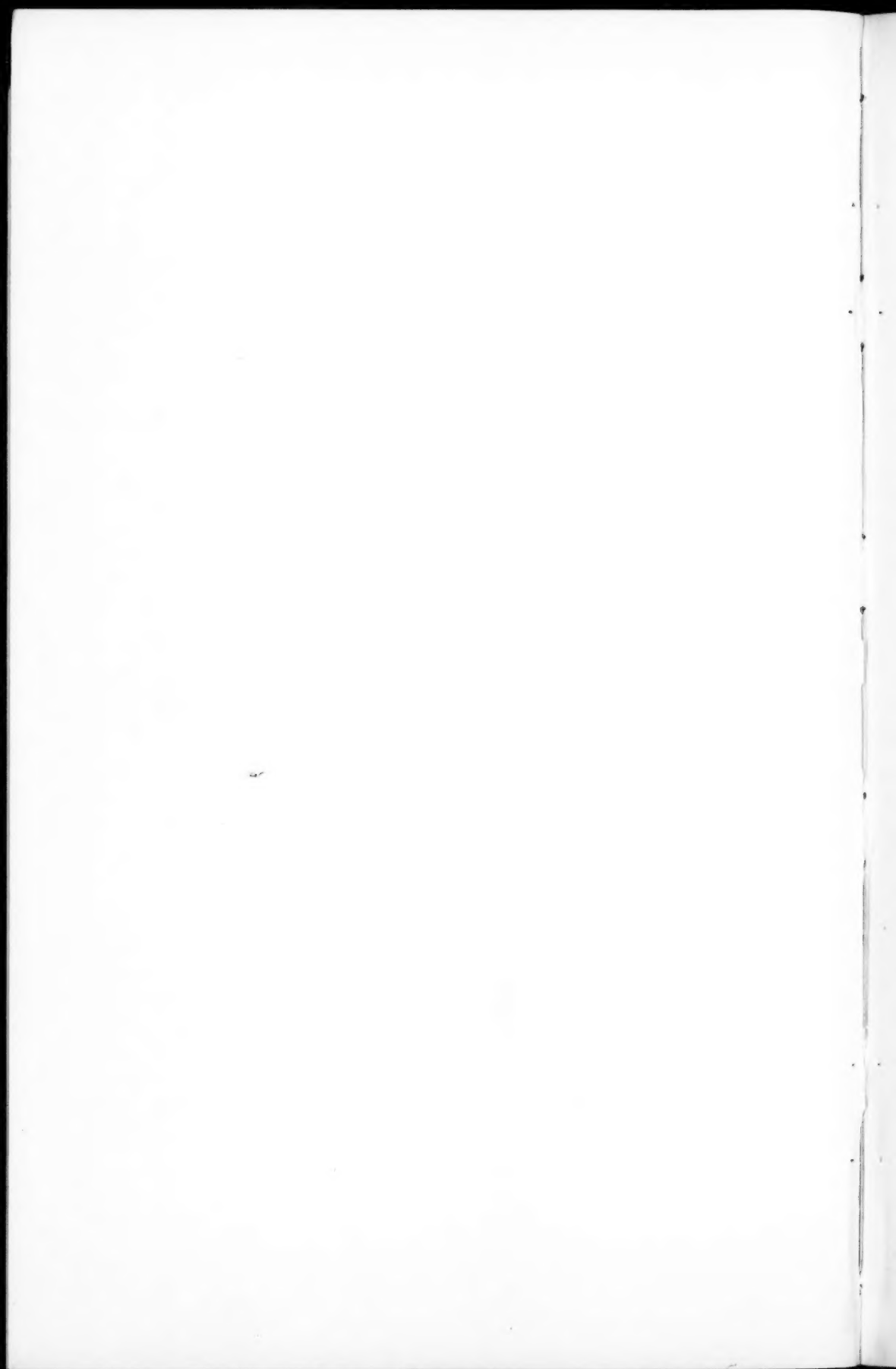
In order to obviate these risks in cases of exstrophy, Maydl¹⁵ (1892) removed the base of the bladder with the ureters attached and transplanted the segment into the rectum as a transperitoneal operation, the ureteral openings being considered as the valves. Other surgeons have projected the area of bladder into the rectum extraperitoneally, the wall of which was closed around the ureters or it was transposed and sutured into the incised rectal wall of which it became a part. Since the majority of the patients in this group are males, they lend themselves readily to such treatment. Russian surgeons, using Maydl's method, report 32 per cent. mortality. Orlov¹⁶ reports 17 cent. mortality in 61 cases and Drucbert's¹⁷ analysis of 81 cases gave 27 per cent. of deaths within 15 days of the operation.

More recently Moynihan¹⁸ has converted much larger areas of the bladder into the wall of the rectum, thus increasing its capacity (Fig. 2). This operation was varied by Lendon,¹⁹ Peters,²⁰ Sherman,²¹ and others by removing the ureters from the wall of the bladder including a small area of attached mucosa which is projected into the bowel. These operations were usually performed extraperitoneally, though Jaja²² converted the method into an intraperitoneal one. In reporting several cases done by the Lendon-Peters method, Buchanan²³ credits Bergenhem²⁴ of Nykoeings with having antedated them by five years (1894). The posterior operation has been performed by Knaggs²⁵ through the Kraske²⁶ sacral resection. Various methods of uniting the base of the bladder or ureter with the anterior rectal wall have been devised, for example, the Boari²⁷ spring button to develop a permanent vesicorectal fistula within a small closed bladder or a ureteral-rectal one by suture, or by the necrosing due to the pressure of forceps. Some surgeons have aimed at half a loaf, by extirpating the bladder after having united the ureters

FIG. 2.



Segment of bladder with ureters inserted into anterior rectal wall.



with the vagina as did Pawlik,²⁸ Sommers,²⁹ Chavasse,³⁰ and others, or with the inner end of the urethra, as done by Sonnenburg.³¹ Interesting and ingenious methods have been advocated by Rutkowski³² and other observers, for example, developing bladders from portions of intestine which are separated from the fecal flow by double section and closure with anastomosis of proximal and distal ends of intestine. The new bladder is supplied by its attached mesentery, and the ureters are anastomosed with it. Connell³³ showed experimentally that unilateral attachment of the ureter was simple, but fatal if the second ureter was also united.

In case the cæcum is thus employed, as in a case reported by Makkas³⁴ (1910), an appendicostomy is made through which the urine is drawn by a catheter passed at regular intervals of a few hours. Surgeons have endeavored to develop a form of cloaca by section of the sigmoid several inches above the rectum, closing the distal end and anastomosing the proximal end to the bowel just above the rectum. The ureters are then attached to the blind extremity, thus aiming to avoid direct fecal contamination. While the urinary flow may wash out the regurgitant fæces, the natural tendency of attached sections of the bowel, out of circuit, is to impact and in that event the desired result would not be obtained.

In the second group of cases are those in which something must be done with the injured ureter when it cannot be reunited to itself or reattached to the bladder, as will occur in the occasional case. The injured ureter may be reunited with the other ureter if that is patent, or one or both ureters may be united to the colon. Mirotworzeff and Tichow³⁵ believe that it is best to unite the ureters to the pelvic colon and that evacuations should be fairly frequent to avoid absorption. Berg³⁶ demonstrated that when the urine traversed the entire length of the large bowel urinary intoxication occurred, which would indicate that the methods used to unite an injured ureter to the end of the appendix are more ingenious than practical, offering no advantages over older methods which have failed. This is also true of the technic used in

Fink's³⁷ fatal case in which the base of the bladder exstrophy was united to the appendix.

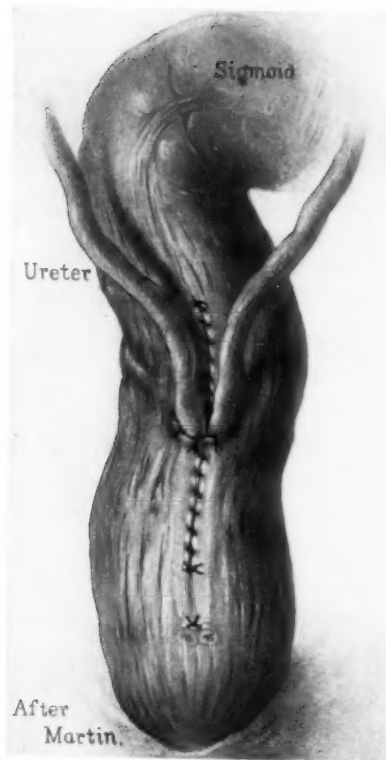
Under some circumstances, the remaining kidney being healthy, one ureter may be tied, causing the death of the kidney. Many observers believe that by whatever method the ureters are attached to the bowel they will frequently transmit infection to the kidney or its pelvis. In this connection Oppel's report is interesting, showing that some pyelitis is common following ureteral anastomosis and that autopsies made years afterward show that the conditions may clear up without a trace of their effects on the kidney.

Direct drainage of the urine to the skin was advised by Ballance and Edwards³⁸ in 1886. This has also been accomplished by pelviotomy and by Watson's³⁹ nephrostomy. In 1896 Harrison⁴⁰ performed the operation and deflected the ureter to the skin of the loin after tying the other ureter. The method was later repeated on both ureters by Bottomley⁴¹ and also by Rovsing⁴² without their knowing of Harrison's work. These operations were done both transperitoneally and extraperitoneally, the urine being collected by special apparatus. The operation is a simple one and can be done in two stages, that is, one kidney or one ureter at a time; the bladder being dealt with or not, according to the condition present. Bovee⁴³ has collected 13 cases of cutaneous ureterostomy.

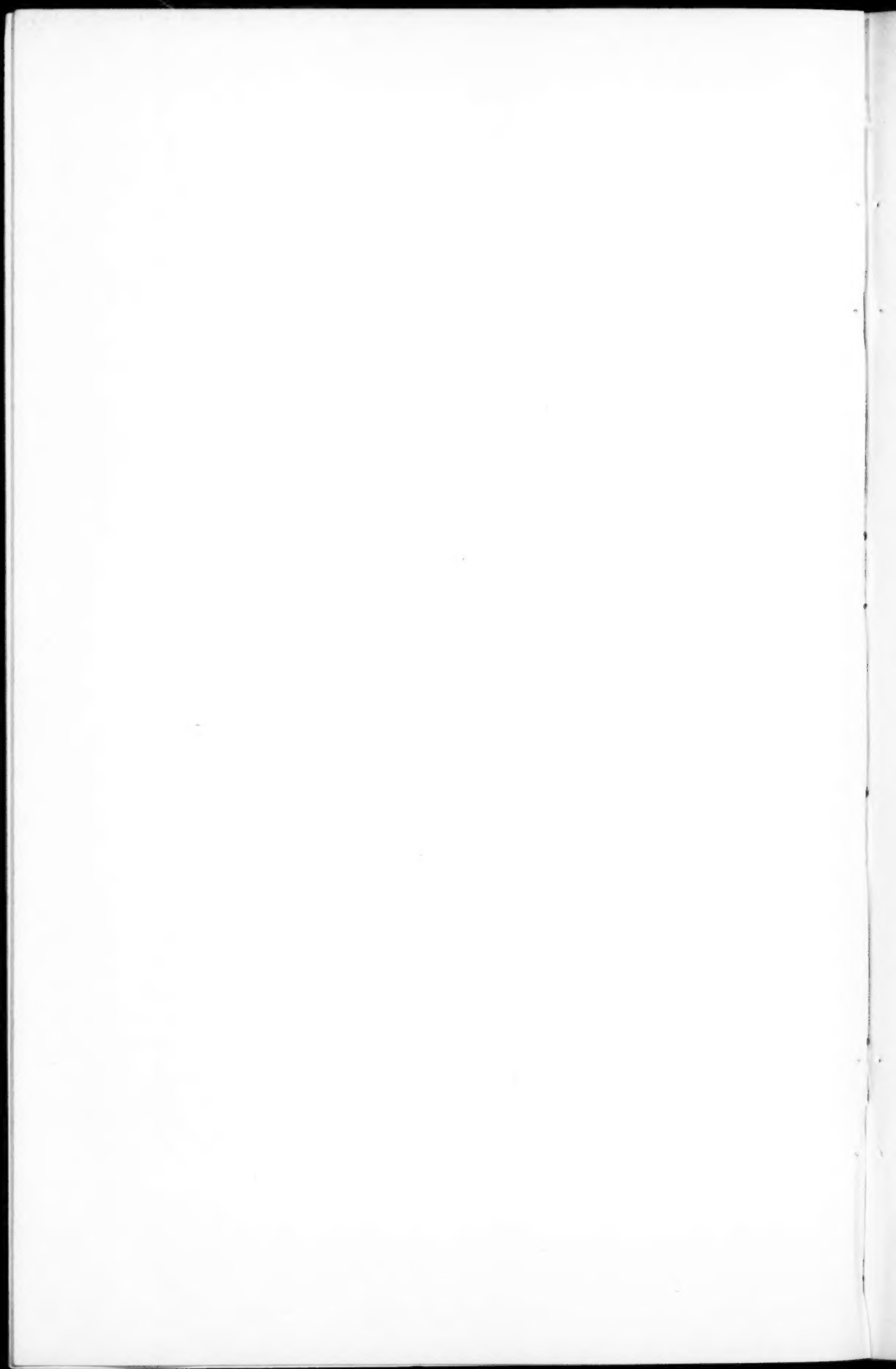
The patients in the third group, namely, those having malignant disease of the urinary bladder, form an interesting and complicated series. Transplanting one ureter into the bladder is no longer a rare operation. Such procedures are satisfactory for the suitable case, in which a controllable bladder will be retained, but other methods are necessary for those patients in whom all of the bladder must be removed or in whom life can be prolonged and comfort secured even though the condition be too far advanced locally or by metastasis to warrant radical procedures.

Tichow and Grammatikati⁴⁴ report 61 cases of neglected cancer of the uterus in which the vagina, bladder, uterus and

FIG. 3.



Double implantation of ureters. (After Martin.)



lymphatic glands were removed and the ureters implanted into the rectum. The mortality was 30 per cent.

The history of the various attempts to transplant the ureters to the bowel is a long one. From a perusal of the voluminous literature on the subject it would appear that the best theoretical and practical operations, when they can be employed, are those which permit the ureters to traverse some distance between the mucosa and outer wall of the bowel before penetrating its lumen or are infolded by the wall of the bowel for a space, and next those methods in which the base of the bladder is transposed and made a part of the rectal wall.

Ureterostomy and nephrostomy to the back is a procedure which may be recommended for special conditions, such as a diseased colon, advanced cancer of the bladder, or of double tuberculosis of the kidney and bladder.

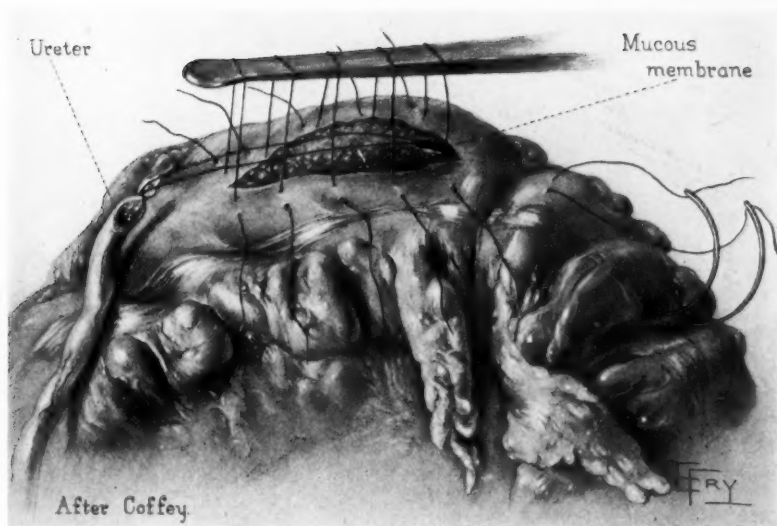
In the year 1790 Petit⁴⁵ called attention to the valve-like openings of the ureters, and it is nearly a half a century since ureteral-rectal and vesicorectal anastomoses were made by Simon,⁴⁶ followed later by Lloyd⁴⁷ and Johnson.⁴⁸ The variety of the valve type of operation was also reported by Fowler⁴⁹ (1898), Martin,⁵⁰ Carl Beck⁵¹ (1899), and later by Frank.⁵² Coffey⁵³ has made an extensive investigation concerning the valve function of the duct openings of both the common duct of the liver and of the pancreas. He has proved experimentally and mechanically that the valve effect is caused by the extension of the duct for some distance between the mucosa and the muscularis (Fig. 3).

Cabot⁵⁴ has shown that the ureter is similarly placed in the wall of the bladder for a distance of one to one and one-half centimetres. Direct transplantation of the ureters failed in not providing for compression of the ducts by internal pressure, thus permitting dilatation of the ureters and regurgitation into them. The method of transplanting the base or a great portion of the bladder into the wall of the rectum is practical, as it then becomes subject to the same internal tension as the rest of the intestine. This method is not difficult of accomplishment in the male.

Those operations in which the ureters are transplanted and have been preserved to their tips are correct only in principle if they are made after one of the methods which secures compression of the lumen.

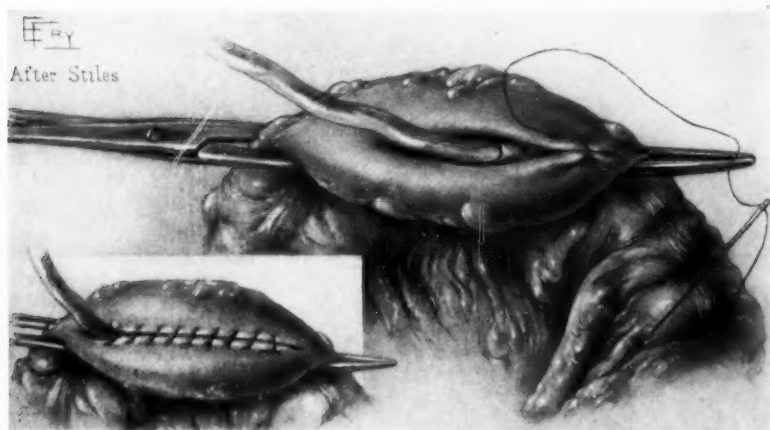
The Coffey operation, practically a divided Martin, is accomplished by separating the ureters that have been isolated and brought through the posterior peritoneum, the distal ends being ligated and buried. A double needled ligature is attached to the split ends of each ureter. At a point as low as convenient the sigmoid is held in a curved rubber-covered clamp to protect against the discharge of intestinal contents. The bowel is then incised longitudinally for one and one-quarter inches through the peritoneum and muscularis, but not the mucosa; the mucosa is perforated at the lower end of the incision. The two needles are passed into the lumen of the bowel through the opening and out of its wall, slightly separated, one-half inch lower down, and are used to draw the ureter through the opening into the lumen, where it is held by tying the two threads. The cut muscularis and peritoneum is now closed over the ureter in the incision by two rows of sutures (Fig. 4). The second ureter may now be attached or preferably the operation delayed for a later period. The Stiles operation (1907) and that of Mirotworzeff, which method is nearly the same and was reported in 1910, secure much the same effect by infolding the bowel over the ureter by numerous sutures, like a Witzel gastrostomy. The deflection of the ureters into the back, as described by Bottomley, is accomplished by a lateral incision, similar to that made in the extraperitoneal operation for stone in the ureter. The ureter is divided, the lower end ligated and the proximal end brought out of the small incision posteriorly and an inch or more above the crest of the ilium, where it is sutured to the skin. This operation has been performed in our clinic from within the abdomen. If indicated at all, we consider this method more applicable for double tuberculous disease or advanced malignancy than to anastomose the ureters with the intestine. Should there be a tendency to close, these openings can be maintained by the use of meatus dilators. Satisfactory urine

FIG. 4.

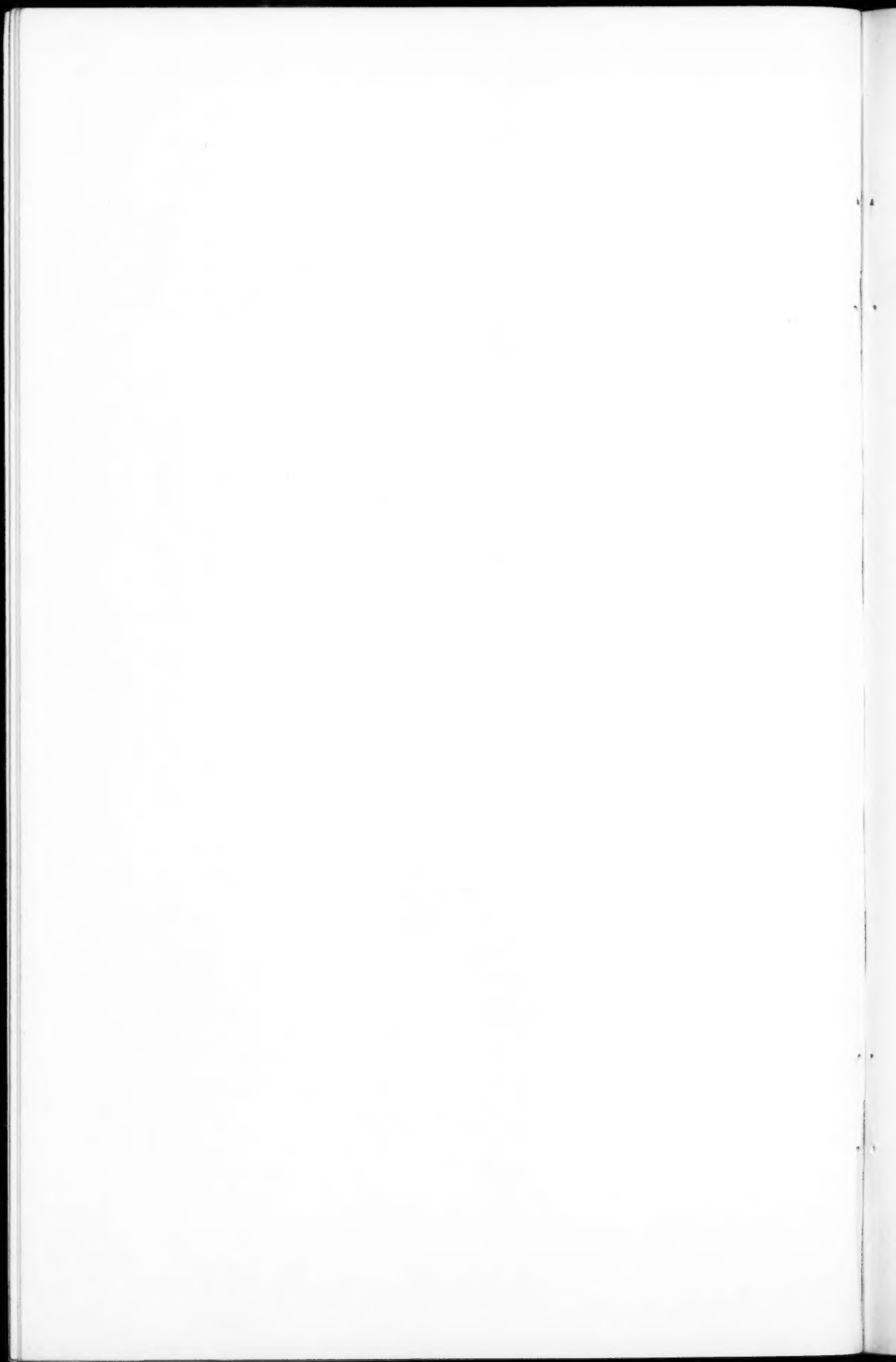


Method of incorporating ureter into large bowel by the division of the peritoneum and the muscularis. (After Coffey.)

FIG. 5.



Infolded ureter in large bowel similar to Witzel gastrostomy. (Stiles's method.)



collectors are easily adjusted by means of a belt (Fig. 5).

Concerning the dangers of necrosis of the ureters: The work of Margarucci⁵⁵ Monari,⁵⁶ and also that of Kobylinski⁵⁷ show that they may be freely separated for several inches without danger of necrosis if left free from tension.

In 1878 Smith⁵⁸ transplanted the ureters into the colon in a case of exstrophy. He noted the intermittent peristaltic delivery of urine from the ureters, and Kelly⁵⁹ has observed that when handled or irritated the peristalsis is stimulated. This point is of value in searching for the ureter within the abdomen. Scratching across the peritoneum over the supposed ureter proves it to be such if the peristaltic wave is seen, since the pelvic portion of the ureter is intimately attached to the posterior peritoneum, which should be remembered in locating them in low extraperitoneal operations.

In our cases of ureteral colonic implantation we have followed Stiles's plan of doing the operation in two stages with an interval of from one to three weeks between. It has been our experience that these operations are not satisfactory in children who are too young to attend to their own bowel movements. The control will be more difficult to secure primarily in these cases, and for a time they will require more frequent attention than before the operation.

Oppel's suggestion to try milk diet after Metchnikoff's⁶⁰ plan of reducing the intestinal bacterial flora is undoubtedly a good one in the preparation of these patients. Oppel depends also on the functional test of the kidneys by giving a hypodermic of indigo carmine, which he considers satisfactory if the urine shows blue in 15 or 20 minutes. Phenol-sulphonephthalein is used as a functional test of the kidney in cases examined in our clinic.

It is hardly necessary to state that the colon should be free from disease when anastomosing the ureters with it. Another point to be remembered in operations on the large bowel is that a laxative should be given two days preceding the operation in order that the contents may again become solid.

In the second group, or cases of injured ureters, it is often possible to implant the ureter into the bladder by the

Coffey or Stiles⁶¹ method, a procedure we accomplished in 8 cases of cancer of the bladder involving one ureteral area. The cancers were removed transperitoneally, transplanting the ureters to the opposite side of viscus while it was open. There were three cases of removal of the bladder for cancer. In one, a female, aged sixty-two, the ureters were transplanted into the rectum by the Stiles method. In spite of a defective kidney and dilated ureters there was a good operative recovery, but sudden death occurred some weeks later from cerebral hemorrhage. In one, a female aged twenty, the ureters were transplanted into the urethra by the Sonnenburg method. This patient made a primary recovery, and died one year later from acute infection of the kidneys. In the third case, a male, aged fifty, the bladder was removed transperitoneally, bringing the ureters into the back. This patient continues in good health, doing farm work for more than three years. In four cases of exstrophy of the bladder in which the organ was removed the ureters were transplanted into the rectum and lower sigmoid by the Coffey method without mortality. Except in children, a day control of from 3 to 5 hours and an all-night retention may be obtained by this method.

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